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THE CHROMOSOMES OF DISPORUM MACULATUM[1]

MARION OWNBEY

CHROMOSOME studies on six of the seven species and varieties of *Disporum* (Liliaceae) native to North America have been reported by Jones (1951) in his comprehensive cyto-taxonomic study of this group. Attempts to secure cytological material of the seventh, *D. maculatum*, for his study, however, were unsuccessful. More recently, living material of this species has been obtained from two sources, and the present account completes the cyto-taxonomic survey of the North American representatives of this genus.

Material available for study included a seedling from plants transplanted originally from Black Mountain, Letcher County, Kentucky, supplied by Dr. E. Lucy Braun, and a plant furnished by Mrs. J. Norman Henry from a collection grown for many years in her garden at Gladwyne, Pennsylvania. There is some question about the original source of the latter plants, but Mrs. Henry is "almost sure" that she collected them near Little Switzerland, Mitchell County, North Carolina. A third plant from Adams County, Ohio, sent by Dr. Braun, did not survive to produce root tips.

The plants were grown outside at Pullman, Washington, and root tips taken in the autumn of 1951 ("Little Switzerland") and summer of 1952 ("Black Mountain"). The root tips were fixed in Belling's modified Navachin's fluid, sectioned at 15 microns, and stained with iodine-crystal violet.

The diploid complement of *Disporum maculatum* (fig. 1) consists of six chromosome pairs ($2n = 12$). The four longer pairs

[1] This investigation was supported in part by funds provided for biological and medical research by State of Washington Initiative Measure No. 171.

have unequal arms of varying proportions. On the fifth pair, no constriction could be detected in any of the material examined, but a thin, lightly stained terminal segment was usually evident. The sixth and shortest chromosome pair possessed submedian constrictions. No important differences in chromosome morphology were noted between the two collections. The chromosomes of "Black Mountain" were noticeably less contracted than those of "Little Switzerland," and the position of the constric-

Figure 1. Chromosomes of *Disporum maculatum.* Mitotic metaphase from root tips. Left.—"Black Mountain." Right.—"Little Switzerland.', × 3100.

tions was not as clear. These differences are probably to be correlated with the temperatures prevailing at the time of fixation rather than attributed to inherent differences between the two collections. No satellites were found on the chromosomes of either collection.

Disporum maculatum adds a fourth base number (n = 6) to those known for the five North American species of this genus. Jones (1951) found *D. Smithii* to have n = 8, *D. Hookeri* (3 varieties) and the very similar *D. lanuginosum* to have n = 9, and *D. trachycarpum*, n = 11. All except *D. maculatum* have one pair of satellited chromosomes. These chromosomal differences are all the more remarkable in view of the striking external homogeneity—vegetatively, at least—of the group. These species today form a small isolated group (the section Prosartes), but the chromosome situation suggests that they represent but a remnant of a one-time large and complicated assemblage.—State College of Washington, Pullman.

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A FLORISTIC STUDY OF COOK COUNTY, NORTHEASTERN MINNESOTA

Fred K. Butters and Ernst C. Abbe

(*Continued*)

7. Presumed History of the Flora of Cook County.

The contemporary flora of Cook County presents the picture of a sea of conifers diluted throughout much of its extent by the lesser hardwoods, such as birch and popple; there are a few islands of hard maple groves; it is dotted with many lakes with their characteristic margin and shallow water species, and also by many bogs; lacing through the forest are streams and rivers with their characteristically narrow zone of aquatics, etc.; and sporadically there occur the much restricted cliff, rock point and other transitory habitats which harbor most of the rarer plants of the county.

It is the rarer plants which immediately hold the attention. But they show no common features as to edaphic factors other than that the soil is new. Some are calcicoles, others quite indifferent. Even the calcicoles cannot be singled out for especial attention because many of the rarities are at the extreme limits of their ranges, and may well be occupying habitats which are atypical. Nor do these plants show common characteristics in relation to temperature and other microclimatic features. Some are found only along the cold zone immediately adjacent to Lake Superior, others only in the sunbaked openings in the conifer woods atop the cliffs.

These rarer plants cannot be disposed of as "pre-glacial relics" —the county was completely submerged under the ice of the Rainy Lobe. Preglacial and postglacial lakes have occupied other extensive areas since Cary time, so that some of the rarities occupy areas only very recently available.

A consideration of the geographical affinities of the plants of these transitory habitats again provides no simple and obvious solution to their current presence in Cook County. Some are at the northern, others at the western, or eastern, or southern limits of their contemporary ranges. In fact there might well be raised

the question of the value of elaborate analyses of the contemporary ranges, especially when the tacit assumption is made that they are static. Ideally the contemporary ranges should be related to the pollen analytical data, were these sufficiently complete (*cf.* Deevey, 1949). By analogy with the position of paleobotany in plant phylogeny, it is obvious that it is the stratigraphic analysis of plant remains (including pollen) which will help to clarify the meaning of contemporary distributional patterns; direct comparisons of contemporary distribution patterns are likely to be just as misleading as the old comparative morphology of living plants often was in arriving at sweeping phylogenetic conclusions. Similarly experimental taxonomy will ultimately help interpret contemporary distributions. Unfortunately the phytogeographer is not yet in a position to utilize these much-desired sources of information. Therefore it is necessary to fall back upon secondary sources of information in attempting to reconstruct the floristic history of the county.

It is not sufficient that the contemporary rarities alone be considered. Their present-day occurrence is so intimately related to the obvious competition provided by the coniferous forest that it and the other components of the flora of the county also require to be taken into account.

Whatever the specific viewpoint, the glacial history of Cook County forces the conclusion that every floristic element, every species (including the ancestral stock of the endemics) must have immigrated into the county since late glacial time, and have migrated considerably within the county once it had arrived. The one feature which all of the plants of the county share is the speed with which they are able to migrate. The following points may be taken as axiomatic in considering the "migration-potential" of the ancestors of the plants composing the contemporary flora of Cook County.

1. They were able to migrate according to any of a variety of means of dissemination, most or all of which are still operative.

2. They came from ice-free regions sufficiently close at hand so that the means of dissemination peculiar to each species could operate; the intervals in space which could thus be bridged vary markedly from species to species.

3. They probably had at least as great ecological amplitude as do their contemporary descendents in the area.

Furthermore it may be assumed that:—

4. Species whose occurrence in the county is disjunct are unlikely to be moving *into* it, but rather this is a manifestation of the disruption of a formerly more nearly continuous range.

5. The highly localized endemic in a geographically recent region is the product of recent speciation which can be rationalized on familiar cyto-genetical grounds coupled with progressive geographical isolation of the parental stock.

6. Some species will migrate independently in the absence of biotic competition given appropriate climatic and edaphic conditions; others will migrate only as part of a favorable community.

7. The interplay of climatic fluctuations and of geographic change, if sufficiently great, is certain to be reflected in the changing distributional patterns of individual species, and in mass movement of plant societies.

The following appears to be the simplest reconstruction of the succession of floristic events in Cook County, taking into account the probable interaction of the climatic, geographic and biotic factors cited in the preceding sections of this paper.

Phase 1. The retreat of the Cary ice; the Two Creeks Interval. The retreat of the Cary ice exposed an area of the Arrowhead which in part remained free of ice during the subsequent Mankato advance. The decay of the Rainy Lobe left great ice blocks stranded in the highly diverse glacial landscape. There were the extensive, unconsolidated ground moraines ranging from acid in the Saganaga granites area to quite calcareous in the Rove Slate area; scratched rock surfaces, stoss faces of cliffs. In addition to the melt water ponded about the ice blocks, there were glacial streams and rivers which coursed across the county, swelling and shrinking, changing, as new outlets formed in the nearby ice margin. On a smaller scale, pond and lake shores, and braided streams have continued to provide new surfaces continuously to the present.

The climate was "periglacial." Whether it was as much less severe as the low latitude suggests is open to question because of the probable southward displacement of the glacial highs. Furthermore the nearness of the great mass of ice, and the presence of numerous large ice blocks must have produced a locally cool climate.

In this cool zone adjacent to the main body of the ice the raw soil provided conditions ideal for the thrifty growth of many arctic and subarctic species. The circumstances were also favor-

able for the dissemination of the seeds of this group of plants. The smooth, essentially unbroken surfaces of the minor tongues of ice, the often glazed winter snow, the absence of trees to act as seed traps, combined with the winds at the margin of the ice provided a set of circumstances not unlike that farther north today. Porsild (1920) has pointed out the importance of the generally small size of the seeds of arctic plants as an adaptation for their dissemination; as he says, "l'utilité de graines et de fruits légers est incontestable dans un pays où le vent constitue l'agent de dissémination de beaucoup le plus important." The prevailing westerly winds gave the great group of plants moving in from the west and northwest a migration advantage over the amphiatlantic group. There may be visualized a gradual eastward drift of arctic and subarctic species, with but a slight progress westward of the amphiatlantic group. There was no doubt an actively interbreeding population of the commoner arctic and subarctic species in this periglacial zone; this is still reflected in the notorious polymorphism of so many contemporary arctic and subarctic species. In general this was aggravated by the innumerable fluctuations of the zone as the various lobes of the ice ebbed and flowed, and temporarily separated breeding groups were again brought into contact.

The width of the tundra "zone" is decidedly problematical; it may well have been discontinuous. Undoubtedly its width varied with the terrain, and was wider when the ice was in retreat. It was surely invaded early and actively by the hardier phase of the coniferous forest, probably most rapidly in the areas of ground moraine which the pioneer arctic species had already stabilized. The unstabilized ground moraine, the periodically inundated flood plains, the bare rock surfaces, the cliffs and their talus slopes would have been invaded more slowly by the forest. However, even these habitats were to a large degree invaded by the coniferous forest as the main mass of the ice receded so that drainage patterns in the county came into balance with precipitation, and as the decay of successive generations of the pioneer species provided humus between the coarser elements of the ground moraine, and as the talus engulfed the smaller cliffs. Wilson (1932, 1936) describes one type of forest presumably of this sort at the Two Creeks site. No doubt a similar

forest developed in Cook County during the Two Creeks Interval. However the arctic-subarctic element must have persisted in quantity in the bogs and on the numerous active talus slopes and in the cool pools and lakes and ravines.

Phase 2. The Mankato advance of the Superior Lobe and St. Louis sublobe (Figure 3 B & C). The Arrowhead region was cut off from the rest of the state by the Superior Lobe advancing westward in the Superior basin and the St. Louis sublobe coming down across the northwest corner of the state. Thus the Arrowhead enclave came temporarily into being. Into it was again introduced the periglacial group of pioneers, perhaps with new species added from the northwest as well as others from the east. However the Arrowhead enclave was sufficiently large so that the hardier phase of the coniferous forest was probably quite capable of surviving. The proglacial lakes of this phase were apparently numerous and the extensive lake shore and lake bottom habitats must have supported a large population of arctic-subarctic aquatics. Thus the arctic-subarctic element of the Rainy Lobe tundra was replenished from the periglacial tundra of the Superior Lobe and farther west from that of the St. Louis sublobe. The continued opportunity for introgressive hybridization in this floristic element seems impressive.

Phase 3. The Glacial Great Lakes (Figure 3 D). With the retreat of the Superior Lobe and of the St. Louis sublobe of the Mankato ice the huge mass of Lake Agassiz and the succession of lakes in the Superior basin came into temporary existence. The climate continued to ameliorate. During this phase the development of a succession of beaches and their occupation by appropriate species occurred on a magnificent scale. This may well have been the period of active immigration from the east of the so-called Coastal Plain element of the Great Lakes flora (*cf. inter alia*, Wilson, 1935). In the country which had remained free of ice and glacial lakes the gradual encroachment of forest on the pioneer fringe and bogs continued as the processes of weathering and erosion led to stabilization of talus slopes and drainage of bogs and lakes. On the other hand the cutting of canyons and of stream banks continued to provide new habitats for some of the pioneers, while the progressive dropping of the levels of the glacial lakes exposed new cliffs and points which were populated

from nearby similar habitats by other members of the pioneer element.

Phase 4. The post-glacial thermal maximum. Continued climatic amelioration permitted the northeastward extension of the hardwoods and even of some prairie elements. This was probably a period of extreme reduction in the extent of the ecological niches suitable for the arctic-subarctic element.

Phase 5. The slight refrigeration following the thermal maximum. Following the thermal maximum a slight refrigeration has led to the restriction of the hardwoods to small groves due to the re-encroachment of the coniferous forest. Probably the arctic-subarctic element has expanded during this phase, perhaps only on a minor scale as wave action and weathering have continued to create fresh surfaces on the cliffs and points.

The history of the contemporary plant cover of Cook County may be summarized as follows:

The oldest elements are those constituting the *Ledum-Chamaedaphne* bogs and the arctic-subarctic species precariously retaining their footholds on the cliffs and rock points. Presumably these species together occupied the periglacial pioneer zone as it migrated into the area next to the edge of the Rainy Lobe. This element was later fortified with new species and many new individuals of species already present by the reintroduction of a similar periglacial group along the front of the Superior Lobe (and farther west, of the Des Moines Lobe). The arctic-subarctic aquatics could also have enjoyed their hey-day in the proglacial lakes at this time.

The Cook County and Great Lakes endemics interestingly enough fall in this oldest floristic element—they are obviously closely related to, or possibly derived from, species of the arctic-subarctic group. The longest time and greatest isolation of breeding populations has contributed to this.

The history of this oldest group of species has been one of almost continuously progressive restriction of suitable ecological niches. The ones that are found there today are "relics" indeed, but relics of a floristic element which reached maximum areal development at middle latitudes *during the height of glacial activity.*

The coniferous forests pushed into the Arrowhead enclave hard on the heels of the plants of the arctic-subarctic fringe and actively took over all suitable habitats.

Only temporarily at the time of the thermal maximum were conditions suitable for an invasion by the hardwoods and some of the prairie species. These enjoyed but a brief period of expansion and have been pinched off into very limited areas by the southward surge of the coniferous forest during the current period of mild refrigeration.

8. Comparison with Other Presumed refugia in Boreal Eastern America

The picture reconstructed above of necessity shows every floristic element of Cook County immigrating into it in late-glacial or in post-glacial time. No alternative is possible because of the glacial history of the county. No recourse is taken in a replenishment of the flora of the North Shore of Lake Superior from a convenient pool of "cordilleran" or "arctic" rarities in the Driftless Area. Any mysterious means of establishing this pool in the first place, or visionary method of getting species no longer represented there up to the North Shore of Lake Superior, requires far more in the way of botanical legerdemain than the procedure proposed above.

It is recognized that Hultén (1937) repeatedly calls for lack of glaciation "on the islands in Lake Superior" or nunatak "districts about the Great Lakes," and that his Plate 43 shows one of the "isolated refugia for biota" in the Nipigon region of the North Shore of Lake Superior. While Hultén follows a somewhat different path in arriving at a conviction that such "non-glaciated" areas exist about the Great Lakes, his fundamental views on this score follow those expressed by Fernald (1925) in his famous essay on "Persistence of Plants in unglaciated Areas of Boreal America" and in subsequent papers. These views are well known and have been reviewed with sufficient frequency (*cf. inter alia*, Raup, 1941; Deevey, 1949) so that detailed recapitulation here is unnecessary. However, some of the areas assumed to have been *refugia*, or "nunataks," or unglaciated areas in the Great Lakes region may be briefly listed and alternative views on their glaciation reviewed.

We may well begin with the North Shore of Lake Superior of which Cook County forms a part. Cook County has been shown to have been completely covered by the Rainy Lobe of the late Cary by Sharp (in prep.). A collecting trip by one writer as far east as Jackfish, Ont., during the summer of 1951 verified the existence there of many of the characteristic rarities of Cook County on cliffs and rock points along this part of the shore of Lake Superior. Many of the areas were submerged under glacial Lake Duluth and therefore possess the same type of raised beaches found in Cook County; the higher points (such

as the top of the Sleeping Giant opposite Port Arthur and Fort William) are not as high as the Misquah hills of Cook County, but like the latter are heavily scored by glacial striae (Tanton, 1931; Leverett, 1929). There is no reason to plead a special case geologically for this area—until it can be demonstrated otherwise, it must be assumed to have shared with immediately adjacent Cook County a common glacial history. It also shares with Cook County botanical rarities, lithological, physiographic and climatic features which make plausible a common floristic history for the whole of the North Shore (at least from Cook County to Jackfish, Ont.). This explanation must assume complete glaciation during the late Wisconsin and the subsequent immigration into the region of *all* components of the vegetation in late- and post-glacial time. Hultén's (1937) deductions concerning the region are wholly untenable.

Isle Royale is a long-famous "haven" for rarities. Perhaps the abundance of these is due in a large part to the absence of fire (Cooper, 1913). Cooper (1913), Leverett (1929), and Brown (1937) recognize that it was completely submerged under Lake Duluth. The first steps in its re-population must have come even later than that of Cook County, including the "cordilleran" element.

The Keweenaw Peninsula on the south shore of Lake Superior is another locality notorious for its rare plants (Fernald, 1935), but it was shown by Bergquist (1937) that it was recently glaciated, and by Leverett (1929) to have protruded but little above the waters of Lake Duluth.

Each of these areas on Lake Superior supports a flora which includes rarities; but each area has also been independently checked geologically whereupon it fails to satisfy the requirements for a nunatak or refugium. The plants are there *now*, but occupy areas recently covered by ice or still more recently submerged under the water of glacial lakes. It becomes necessary, if a nunatak theory is to be maintained as a philosophical necessity, either to relegate such refugia to still unexplored areas or to retreat southward to the Driftless Area. Either procedure demands that the rarities of today migrate across a terrain already heavily mantled by vegetation. It is far more reasonable to recognize the limitations of these species which restrict them

to migration under the more favorable conditions for dissemination found in a periglacial zone in late glacial time, or along the strand and shore rocks and cliffs of the glacial lakes.

These observations might be extended still farther east. Stebbins (1935) is sharply opposed to the Fernaldian concept of "persistence" as applied to the cordilleran rarities of the Bruce Peninsula on Lake Huron. He properly calls attention to Fassett's (1931) objection to Fernald's (1925) hypothesis that the "cordilleran" element of the Great Lakes flora survived in the Driftless Area and migrated in post-glacial time to their Great Lakes localities. Instead Stebbins, with especial emphasis on the Bruce Peninsula, advocates and implements the view which Fernald (1925, p. 292) discarded. In Fernald's words this is, "It is wholly conceivable that the isolation about the Gulf of St. Lawrence and in the cordilleran region of many plants is due to a gradual migration during the late stages of the Pleistocene along the cold fronts of the continental ice-sheets, the plants now restricted to cold and alpine or bleak habitats about the Gulf of St. Lawrence and in the West having found, upon the disappearance of the ice, congenial habitats in the Northeast and in the Northwest and occasionally about the headlands of Lakes Huron and Superior; the hot and dry summers of the lower or flatter areas between these three isolated regions soon proving wholly forbidding to these species, with the inevitable result that they have quite vanished from the broad intermediate regions. Such an explanation would be at once simple and reasonable and it is entirely possible that some interchange of this sort actually took place."

In the Gulf of St. Lawrence region the geological evidence again fails to support the nunatak hypothesis. This was brought out emphatically by Wynne-Edwards in his critiques (1937; 1939) of Fernald's views. In his detailed study of the Gaspé-Bic area, Scoggan (1950) confirms in detail the presence there of its characteristic rarities and cites Alcock's testimony that it was not in any part a nunatak area. The latter view is supported in a modified form by Flint, Demorest and Washburn (1942). Similarly MacClintock and Twenhofel (1940) consider that the Long Range of Newfoundland was glaciated, and Flint (1940) states that "Newfoundland was strongly glaciated during the latest (presumably Wisconsin) glacial age." Other botani-

cally significant areas are the Mingan Islands and Anticosti. These unquestionably were heavily glaciated and subsequently submerged under the waters of the Champlain Sea. Farther east at the Straits of Belle Isle the sharp line at the upper limit of this submergence is marked by the numerous perched boulders above it. In 1929 Dr. Harrison F. Lewis and the writer made an inland excursion (Lewis, 1931) to the top of Mt. Cartier (elev. 1264 ft.) near Bradore Bay to determine the upper limit of these erratics and found them even on the very summit. Nor was there botanical evidence even at this elevation of this having formerly been a "nunatak"!

Farther north the writer (Abbe, 1936) in examining the flora of the Kaumajet and Torngat regions found on the mountain tops a flora composed of the hardiest of arctic species. The "cordilleran" species occur at lower elevations. The geological evidence led Odell (1933) to the conclusion that the highest points of these two areas were inundated by the Labradorian ice. It was concluded that if, contrary to the geological evidence, nunataks had existed here at the height of glaciation they would have supported the growth of only the ubiquitous, arctic forms such as now grow on these mountain tops. Therefore the "cordilleran" element could only have survived on the precipitous ice-free forelands (by analogy with Greenland) or, if the forelands were also ice-covered, there must have been immigration of *all* floral elements during post-glacial time. The source of these was assumed to be in the "driftless areas of the St. Lawrence region." The geological evidence which has become available since 1936 makes it extremely unlikely that such refugia existed to the south. It becomes necessary to adopt for this area the same conception that I have adopted for the Cook County area, and which logically applies to the entire intervening region peripheral to the last ice sheets. The relics, including the "cordilleran" ones (which actually cannot be sharply differentiated from the arctic-alpine group), are relics of a late-Wisconsin dispersal; migration was most active when the maximum areas were temporarily available for dispersal and colonization and before the encroachment of the boreal forest. Subsequent survival at the periphery of the glaciated area suggests, for the rarities, the existence of suitable ecological niches *through* the climatic optimum.

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9. The Botanical Exploration of Cook County

It might well be expected that the first botanical records for Minnesota would be from Cook County because of the presence there of Grand Portage, the pre-Revolutionary "commercial emporium" of the fur empire of the old North West. But botanizing in the North West began after the trade routes had shifted away from Grand Portage—and the botanical collector tends to follow paths kept open by commerce or governmental agencies. Thus information was piling up concerning the flora of the regions to the west and south (*cf.* Upham, 1884) and immediately to the east (Agassiz, 1850), but not for our area (at least, insofar as records in the Herbarium of the University of Minnesota are concerned).

The first significant and usable collections from Cook County that are represented in the Herbarium of the University of Minnesota were made in the summer of 1879 by Thomas S. Roberts (1880), then a student at the University. Roberts was later to become a famous doctor in the Twin Cities, an outstanding authority upon birds, and ultimately the founder and the first director of the Museum of Natural History at the University of Minnesota. Roberts, with other members of a small party, including Professor C. W. Hall (1880), the geologist, made an

adventurous trip by boat from Grand Marais to Duluth during the summer of 1879, spending the latter part of July and much of August in Cook County. Only the previous year a government trail had been opened from Duluth to Grand Marais, but this, according to Hall (1880), was "chiefly for the dog trains that carry the Canadian mails . . . when navigation . . . is closed by the ice." The country was an essentially untouched wilderness, so that the party of necessity confined its activities primarily to the shore, but with trips inland to Devil's Track Lake and to Carlton Peak. The party spent several days at Grand Marais (then a "settlement" of but one house!) and while there collected several specialties of "The Point"—notably *Polygonum viviparum, Primula intercedens, Euphrasia hudsoniana,* and *Pinguicula vulgaris.* Farther west along the shore at Black Point, Roberts collected the very rare *Calypso bulbosa* and at the Cascade River, *Cystopteris fragilis* var. *laurentiana* (a variety not since collected in Cook County).

A considerable number of specimens was collected along the North Shore during the summer of 1878 by B. Juni (1879); however, the label data are so scanty that the plants seldom can be assigned to a specific locality, nor is the information given in his published list of great help in this regard.

The next major collections from Cook County were made in June and July, 1891, by L. S. Cheney and F. F. Wood (*cf.* Cheney, 1893) who made a canoe trip along the Border Lakes following Mackenzie's toilsome route westward from Grand Portage. Their collections are numbered separately, but it is evident from a comparison of their itineraries as based on their label data and from Cheney's report (1893) that they were working together. Most of the "good" records are credited to Cheney in the annotated list which follows this, perhaps because of some accident of distribution of the duplicate sets found in the Herbarium of the University of Minnesota. Before starting their trip inland by way of the ancient canoe route along the Border Lakes, Cheney and Wood collected at Grand Marais and there made important additions to Roberts' records, namely, *Selaginella Selaginoides* (subsequently collected but seldom in Cook County), *Luzula parviflora, Tofieldia pusilla* (otherwise known in Minnesota from Two Harbors down the Lake Superior

shore), *Listera auriculata* (otherwise known in Minnesota only from Grand Portage and Duluth), *Ranunculus lapponicus* (as reported in Cheney's list, but not represented in the Herbarium of the University—certainly one of the rarest of Minnesota plants), *Halenia deflexa,* and *Phacelia Franklinii* (not again collected in Cook County until 1937 at Mountain Lake). They went on to Grand Portage and there found *Vaccinium uliginosum* (collected only once again in the county in 1937) and *Castilleja septentrionalis* (not yet re-discovered in Cook County). In spite of their eye for rarities, Cheney and Wood oddly enough seem not to have collected any of the equally significant and localized species which occur on the cliffs and the talus slopes along the Border Lakes—perhaps because their schedule forced them into a haste which did not allow them time for the necessary scrambling and painstaking search involved in working the cliffs.

Conway MacMillan, founder of the Department of Botany at the University of Minnesota, visited the Border Lakes in Cook County in early September, 1895. On this trip his primary botanical objective seemed to be lower forms as it seems to have been on other trips to the county (*cf.* Conklin, 1942) because a search of the University of Minnesota Herbarium has brought to light no vascular plants collected by him at this time. He was at Grand Marais and Carlton Peak again in 1900, but again collected few vascular plants.

In August of 1901 MacMillan again went to Cook County, accompanied by two of his students, Charles J. Brand (later to become a well-known economic consultant and agricultural administrator) and Harold L. Lyon (subsequently Director of the Experiment Station of the Hawaiian Sugar Planters' Association). This was a walking trip along the Gunflint Trail to the Border Lakes. The trip yielded first records of those elusive aquatics *Isoëtes macrospora* and *I. muricata,* not collected again from the county for many decades. Mr. Brand has described this trip in a long letter[5] from which the following is taken.

"A small but comfortable lake boat transported us from Duluth to Grand Marais. During much of the trip the shore was in view, and I always remember with amusement that when Professor MacMillan pointed out the mouth of the Temperance River he told us it was so

[5] *In litt.,* November 14, 1947; omissions from the quotations given above not indicated.

called because the wit who christened it discovered that the usual sand bar was missing at the mouth of the river where it flows into Lake Superior.

"On arrival at Grand Marais, we went immediately to the little clapboard, tarpapered hotel. In those days the village appeared to have about 100 inhabitants, and the whole surrounding territory had only a small sprinkling of settlers, a few of them white families but most of them Indians. Dr. Mayhew and one of his kinsmen also owned the trading post where timber cruisers, prospectors, and occasional geologists and other scientists like ourselves outfitted to invade the hinterland.

"The tramp up the Gunflint Trail was tough in some ways for rather soft white-collar workers, but we enjoyed every hour of it. From the Brule we toiled on to Hungry Jack Lake where we took our canoes and went to South Lake, then to North Lake, and finally to Gunflint Lake on the International Boundary, portaging where necessary. The most striking discomfort of the trip came after we got into the Gunflint and Saganaga Lakes area where billions of mosquitoes and gnats infested the air above the small islands, actually forming clouds.

"At the conclusion of our botanical explorations, we proceeded to the town of Gunflint which was the western terminus of the even then outmoded Port Arthur, Duluth and Western Railroad. We took train to Fort William and Port Arthur. We had been out about a month, sleeping on pine boughs under the sky, so that our first night in the hotel in Port Arthur almost suffocated Lyon and me, and we placed our bedding on the floor of our room in order to be able to breathe and sleep."

Obviously collecting in those days was carried out under difficulties not unfamiliar to the camper and canoeist of today in the same region.

It was at about this time (1897) that J. M. Holzinger collected lower forms in Cook County (*cf.* Evans, 1899). He also added at least one important record among the higher plants—*Cypripedium arietinum* at Gunflint Lake, not again collected in the county. Holzinger again collected hepatics in Cook County in 1902 (*cf.* Evans, 1903).

In 1906, Lyon returned to Cook County, collecting in the vicinity of Grand Marais and there added the rare *Equisetum scirpoides* to the record.

In 1912, Professors C. O. Rosendahl and N. L. Huff spent part of August in the county, most of their collections being from the vicinity of Kimball Creek, where they found *Chrysosplenium americanum,* later collected in the county only at the Devil's Track River by Butters and Rosendahl in 1924.

The first extensive collections from Cook County were made by Professors F. K. Butters and C. O. Rosendahl early in the

summer of 1924. It is no mere coincidence that this was the era of the Model T Ford and that old Highway No. 1 (see Rosendahl and Butters, 1925), from Duluth to the Canadian border at the Pigeon River had been opened but a few years previously and had been improved as far as Little Marais the year before. The area in which they collected followed the course of the highway eastward along the shore of Lake Superior and then swung inland back of the Grand Portage area. Several important additions to the flora were made on this trip:—*Woodsia alpina*, one of the rarest of Cook County ferns was found at the Devil's Track and Poplar Rivers; *Poa saltuensis* at the "Carribeau" River and its variety *microlepis* at Mineral Center (and not again collected in the county); *Listera convallarioides* at Mineral Center (the only record for Minnesota); and the very local *Saxifraga virginiensis* at the Pigeon River.

It was in 1927 when Dr. Butters was on a non-botanical trip with a group of friends that his interest in the flora of the county as such was actively kindled. He stopped in at Grand Portage to visit his friends, Professor and Mrs. Solon H. Buck, historians who were on a sort of busman's holiday in this most historical of spots in Minnesota. While there, although it was September, Dr. Butters noted the occurrence not only of some of the specialties already known from "The Point" farther west at Grand Marais, but he also found *Sagina nodosa*, and on a similar visit two years later (also in September) found *Woodsia glabella* and *Cryptogramma Stelleri*.

Mr. and Mrs. F. R. Benner, high school teachers in Minneapolis and former students in the Department of Botany at the University, made an extensive collection while vacationing at Grand Portage during July and August of 1929. Their general collecting established a sound basis for a knowledge of that area, and they added to the list of rarities *Parnassia palustris* var. *neogaea*.

Dr. Rosendahl returned to Cook County in August 1929 with P. A. Rydberg who was visiting the Herbarium of the University while preparing his *Flora of the Prairies and Plains*. Rydberg and Rosendahl collected primarily in the Grand Portage area and added several new records to the flora of the county:—*Stellaria calycantha* (typical), unknown elsewhere in the state;

Crataegus Douglasii, a western hawthorn thoroughly at home in the thickets at Grand Portage; and *Empetrum atropurpureum* from Susie Island near Grand Portage.

In August 1930, Butters and Rosendahl again visited the Grand Portage area and made a brief side trip afterwards to some of the lakes in the Rove Slate area. The latter part of the excursion was made largely on the basis of the interesting reports which their friends Professors Grout and Schwartz of the Geology Department were bringing back as a result of their field work in that area. At and near Grand Portage Butters and Rosendahl made several significant new finds:—*Dryopteris spinulosa* var. *dilatata* on Lucille Island and at Grand Portage, the first and only collections in Minnesota; *Scirpus hudsonianus*, *Spiranthes Romanzoffiana*, and *Viola adunca* var. *minor* at Grand Portage; *Crataegus columbiana*, var. *Piperi* at the site of Fort Charlotte.

Dr. Butters and his student Murray F. Buell (now a Professor at Rutgers University) made the Border Lakes in the Rove Slate area their major objective in July of 1932. Here they found still more rarities growing on the slaty cliffs and talus slopes. They explored the Clearwater Lake cliffs especially, finding there *Woodsia scopulina* (which had turned up earlier at Grand Portage), *Danthonia spicata* var. *pinetorum*, a *Poa* of the *laxa* group which was later to be described as *P. scopulorum* (Butters and Abbe, 1947) known so far only as Cook County endemic, *Saxifraga Aizoon* var. *neogaea* (Butters, 1944), and the exciting *Arnica chionopappa* (Plate 1190-C) localized on only one talus slope in Cook County and known otherwise in Minnesota from farther west along the shore of Lake Superior where it was later found by Professor Olga Lakela. At near-by East Bearskin Lake, Butters and Buell turned up the infrequent *Eriocaulon septangulare*.

Etlar Nielsen, then a graduate student working on *Amelanchier*, made his first collecting trip to Cook County in September, 1932, and in the course of his general collecting at Clearwater Lake found *Polygonum Douglasii*, not again collected in Cook County. Nielsen made three more trips to Cook County, one with F. Egler in June of 1933, another with W. J. Breckenridge, now Director of the Museum of Natural History at the University of Minnesota, in June of 1935, and a third with Dr. J. W.

Moore in October of the same year. On the basis of the collections of *Amelanchier* made on these trips, Dr. Nielsen has published a very complete inventory of the *Amelanchiers* of the state. The following were collected in Cook County for the first time by Nielsen: *A. huronensis* Wieg.; *A. humilis* Wieg., var. *compacta* Nielsen; *A. mucronata* Nielsen (an endemic species known only from Clark's Bay), *A. Wiegandii* Nielsen, *A. canadensis* (L.) Medic.

In June, 1936, Dr. Butters and the junior author visited Cook County. The Border Lakes (Plate 1190-A) again received careful attention which was rewarded by several new records for the state as well as for the county:—*Carex deflexa* from Clearwater Lake, and *C. xerantica* and *Osmorhiza obtusa* from near-by Watab Lake. The rare *Carex Backii* known from only three other localities in Minnesota was found at Watab Lake, and *C. supina* (reported under its synonym *C. obesa* All., var. *minor* Boott by L. H. Bailey, 1892, from South Fowl Lake on the basis of an F. F. Wood collection) was collected at Clearwater Lake.

In July, 1937, Dr. Butters, Mrs. Abbe and the junior author collected again along the Border Lakes and at Grand Portage. At Mountain Lake we collected *Calamagrostis purpurascens* not previously known from Minnesota, and there Mrs. Abbe found an exceptionally limited colony of *Saxifraga cernua* var. *latibracteata* also new to the state. On the dry edges of the bluffs of Watab Lake *Arenaria macrophylla* was discovered, and out on Pigeon Point *Deschampsia flexuosa*, another "first" for the state. Mrs. Abbe and the junior author returned to the Grand Portage area for a few days in August of 1937 and then found *Draba norvegica* on Susie Island, a new record for the Great Lakes basin, and just over the International Border on the north side of Pigeon Bay (in the Thunder Bay District of Ontario) *Senecio eremophilus* which has not yet been collected in Minnesota. There also Mrs. Abbe found on the sun-baked cliffs a hybrid *Woodsia* which Dr. Butters (1941) subsequently named *W.* × *Abbeae* for her.

The following year (1938) Dr. Butters returned in early July to the Rove Slate area, taking with him G. W. Burns and M. J. Hendrickson, then graduate students in the Department; the former is now on the staff at Ohio Weslyan University and the latter is with the Hormel Research Foundation. At Mountain

Lake the trio added *Asplenium Trichomanes* and *Arabis Holboellii* var. *retrofracta* (the only record for the state). Throughout July and into early August, Burns and Hendrickson continued collecting systematically in the Rove Slate area, making the notable discovery at South Fowl Lake of a puzzling *Oxytropis* which was in a sterile condition. At Clearwater Lake they added *Carex ormostachya*, a new record for Minnesota.

Dr. Butters was much intrigued by the unknown *Oxytropis* which Burns and Hendrickson had located and accompanied by Dr. J. W. Moore made a brief trip in early July of 1939 in an attempt to find it in flower. In this objective he was unsuccessful, but as usual several new records were obtained:—*Botrychium multifidum* var. *intermedium* at John Lake; *Equisetum palustre* (apparently the European typical state), *Habenaria dilatata*, and *Microstylis unifolia*, all at Grand Portage.

Dr. Butters was determined to get flowering and, if possible, fruiting material of the unknown *Oxytropis*, so with this object in mind he returned to Cook County in late June and early July, 1940, with the junior author and G. W. Burns as companions. This time the quest was successful and an abundance of the endemic *Oxytropis* in flower (Plate 1190-B) was obtained on the American side of South Fowl Lake—this to be subsequently named *O. ixodes* Butters and Abbe (1943); also a well-marked form of it, *O. ixodes*, f. *ecaudata* Butters and Abbe was found on the Canadian side of North Fowl Lake. Along with the latter were also found *Carex Rossii* (known in Minnesota only from Carlton County), and *Cerastium beeringianum* (not yet collected in Cook County). From the American side of North Fowl Lake we collected *Shepherdia canadensis*, very uncommon in Minnesota; and at South Fowl Lake, *Ranunculus Macounii* (known from two other localities in Minnesota). Later during this same summer Professor Olga Lakela made at Sea Gull Lake the only collection of *Cypripedium Calceolus*, var. *parviflorum* for the county. In her characteristically enthusiastic and meticulous fashion she has also collected in Cook County during 1941 and 1944, on the latter occasion making at Schroeder the only collection for the county of *Potentilla gracilis* var. *pulcherrima*.

Dr. Butters' last summer of field work in Cook County was from late July to mid-August, 1944, when the junior author

again accompanied him. The object of this trip was to check the manuscript of the accompanying Annotated List (Section 12) in the field and to add to it such records of weeds, aquatics, etc., as may have been passed over during earlier intensive searching for the rarities of the county. We also wished to check a possible new species of *Poa* at its type locality on Clearwater Lake before publishing on it. The *Poa* turned out to be readily recognizable in the field and was subsequently described as *P. scopulorum* Butters and Abbe (1947), an endemic of the *P. laxa* group. In addition to checking our records and adding a number of weeds, several new records for Cook County were obtained on this trip:—*Botrychium matricariaefolium* at Lima Mountain, *Subularia aquatica* at Poplar Lake (the only collection for the state), *Elymus Wiegandii* and *Salix pellita* (new to Minnesota) at Grand Portage, *Plantago virginica* along the roadside west of Grand Marais (new to Minnesota and curiously out of range), and in a roadside ditch near Schroeder, *Eleocharis nitida* and *Liparis Loeselii*. It was on this trip that we found, much to Dr. Butters' delight, *Betula pumila* var. *glandulifera* for the first time for the county. It is by no means a rare plant in Minnesota generally, but in Cook County had evaded us for many years. Dr. Butters had predicted that it would turn up when the acid Archean granite country was carefully searched, since it seemed to be consistently absent from the neutral and basic country in which we had spent most of our time previously. It was a minor triumph for Dr. Butters when it proved indeed to be present in quantity in the bogs of the extreme northwestern part of the county.

There remained as botanically unexplored the western part of the county in the general vicinity of Sawbill Lake. When therefore John De Q. Briggs, headmaster of St. Paul Academy, and his accomplished wife, Mrs. Marjorie W. Briggs, both excellent amateur taxonomists, offered in 1945 to collect for us at Sawbill Lake we accepted with alacrity. We knew that they and their son, Winslow Briggs, were most discriminating and successful orchid hunters, so we were not surprised, although we were nonetheless pleased, when they came back with *Pogonia ophioglossoides* and *Arethusa bulbosa* as new records for the county; to these they had also added *Scheuchzeria palustris*. On a subsequent trip the Briggs turned up *Habenaria psycodes*, another

novelty for the county, thus continuing to add to their laurels as orchid specialists.

From the Department of Botany, Dr. and Mrs. Schuster, although primarily concerned with Hepaticae, collected some vascular plants in the summers of 1947 and 1948. Records of rarities have been verified, and additions, such as *Triglochin palustris* and *Houstonia longfolia*, made. Dr. and Mrs. Ownbey visited Cook County in August of 1948 and then turned up *Empetrum nigrum* and *E. atropurpureum* on the Susie Islands off Grand Portage.

While their objectives in carrying on botanical work in Cook County did not allow their representatives time to collect appreciable numbers of specimens, the Minnesota Department of Conservation and the U. S. Forest Service should be mentioned here as having contributed to a knowledge of the flora of the county. Through the good offices of Dr. J. B. Moyle of the Minnesota Department of Conservation, representative collections made by field men working in Cook County have been deposited in the Herbarium of the University of Minnesota. And a number of collections made in Cook County by U. S. F. S. employees have been made available by Mr. D. M. Stewart, Pathologist in Charge of Blister Rust Control, of the Duluth office of the U. S. D. A., Division of Plant Disease Control. Mr. Stewart himself has had extensive field experience in Cook County in connection with white pine blister rust control and has generously shared his information with us.

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10. Summary of Major Collections from Cook County

A summary of the more important collections is presented in the following table. Only those collections which total more than a hundred numbers have been included, except in the case of the first collection from each of the three regions into which, for the sake of convenience, the county has been subdivided. The collections are arranged in alphabetical order of collector by identifying initials. It is these identifying initials which are used in the Annotated List which constitutes Section 12 of this paper.

TABLE II

Summary of Major Collections from Cook County, Minnesota

Collection Numbers	Collectors	Date	Lake Superior watershed west of Grand Portage	Vicinity of the Border Lakes	Pigeon Point area including Grand Portage
AA 500–610	Abbe, L. B. & E. C.	Aug. 18–21, 1937			x
Be 467–704	Benner, F. R. & J. S.	Jul. 27–30; Aug. 20–29, 1929			x
Bg 1–124	Briggs, J. DeQ. & M. W.	Aug. 2–16, 1945	x		
BsH 152–430	Burns, G. W. & Hendrickson, M. J.	Jul. 17–Aug. 7, 1938		x	
B	Butters, F. K.	Sept. 1–3, 1927			x
BA 1–219	Butters, F. K. & Abbe, E. C.	Jun. 20–30, 1936		x	x
BA 754–1090	Butters, F. K. & Abbe, E. C.	Jul. 27–Aug. 15, 1944	x	x	x

TABLE II—*Continued*

Collection Numbers	Collectors	Date	Lake Superior watershed west of Grand Portage	Vicinity of the Border Lakes	Pigeon Point area including Grand Portage
BAA 220–470	Butters, F. K. & Abbe, L. B. & E. C.	Jul. 2–14, 1937		x	x
BABs 611–713	Butters, F. K. Abbe, E. C. & Burns, G. W.	Jun. 27–Jul. 3, 1940		x	
BBl 328–478	Butters, F. K. & Buell, M. F.	Jul. 7–19, 1932		x	x
BBsH 1–151	Butters, F. K., Burns, G. W. & Hendrickson, M. J.	Jul. 3–13, 1938		x	
BM 10763–10888	Butters, F. K. & Moore, J. W.	Jul. 1–5, 1939		x	x
BR 4462–4697	Butters, F. K. & Rosendahl, C. O.	Jun. 29–Jul. 8, 1924	x		
BR 6200–6387[6]	Butters, F. K. & Rosendahl, C. O.	Aug. 29–31, 1930		x	x
	Cheney, L. S.[7]	Jun. 20–Jul. 25, 1891		x	
D 1–191	Dahl, A. O.	Jun. 15–22, 1945		x	
L 3605–3724	Lakela, O.	Jul. 4–6; 13, 1940		x	
L 4700–4837	Lakela, O.	Aug. 9; 17, 1941	x		
N 1618–1730	Nielsen, E. L.	Sep. 9–14, 1932		x	x
NBr 3157–3243	Nielsen, E. L. & Breckenridge, W. J.	Jun. 8–9, 1935	x		
OO or OS 982–1155	Gerald B. Ownbey and Findley Ownbey or R. M. Schuster	Aug. 11–20, 1948	x		x
S (S) misc. nos.	R. M. Schuster (and in part, O. M. Schuster)	Misc. dates 1947–48	x		x
	Roberts, T. S.[8]	Jul. 27–Aug. 25, 1879	x		
R 5956–6082[6]	Rosendahl, C. O. (& Rydberg, P. A.)	Aug. 9–17, 1929			x
	Wood, F. F.[7]	Jun. 20–Jul. 25, 1891		x	

[6] On the labels of these specimens the collector is often given as Rosendahl, only.

[7] Cheney and Wood are listed separately because the labels on plants collected on their trip carry only the name of one or the other as collector.

[8] Accompanying Prof. C. W. Hall. The latter made a few collections under his own name.

Note: inadvertently omitted from the above are the following abbreviations:—NE, representing Nielsen & F. Egler (June, 1933); NM, representing Nielsen & J, Moore (Oct., 1935).

11. Place Names in Cook County

In the *Annotated List* which constitutes Section 12, specific collections, in the interests of conserving space, are referred to the nearest *major* geographic feature. These localities are, however, shown only on the most detailed maps. In order that they may be located rather closely on the map of the county presented in Figure I, township and range as well as latitude and longitude are shown on it. The place names in the following list are accordingly identified by township and range.

The place names cited below are primarily those in current usage as represented by Grout and Schwartz (Minn. Geol. Surv. Bull. 24. 1933) U. S. D. A., Forest Service (Map of the Superior National Forest. 1938); Smith and Moyle (Minn. Dept. Cons., Div. Game and Fish, Tech. Bull. 1. 1944); and the general highway maps of the Minnesota Department of Highways. Earlier usages may be sometimes found by referring to Winchell (vol. IV, Final Report, Geol. and Nat. Hist. Survey Minn., pp. 313–345 and 481–521. 1899) and to Upham (Coll. Minn. Hist. Soc. vol. 17. 1920).

Gazetteer

Agnes Lake (T 61 N, R 3 W); Alder Lake (T 64 N, R 1 E); Alpine Lake (T 65 N, R 5 W); Alton Lake (T 62 N, R 5 W); Arrowhead River—see Brule River; Aspen Lake (T 64 N, R 1 W).

Bally Creek (T 61 N, R 1 W); Belle Rose Island (T 63 N, R 7 E); Big Cherry Portage—Moose Lake to Lily Lake; Birch Lake (T 65 N, R 1 & 2 W); Black Point (T 60 N, R 2 W); Brick Island (T 63 N, R 7 E); Brule Lake (T 64 N, R 2 & 3 W); Brule River—on the Gunflint Trail (T 64 N, R 1 E); Brule River—mouth of (T 61 N, R 3 E); Burnt Lake (T 62 N, R 4 W).

Canoe Lake (T 64 N, R 1 E); Caribou Lake (T 65 N, R 1 & 2 E); Carlton Peak (T 59 N, R 4 W); Carribeau River—mouth of—see (?) Poplar River; Cascade River—mouth of (T 60 N, R 2 W); Christine Lake (T 61 N, R 3 W); Clark('s) Bay (T 64 N, R 7 E); Clearwater Lake (T 65 N, R 1 E); Cock Portage—Pigeon River to South Fowl Lake; Cross River (northern) (T 65 N, R 3 & 4 W); Cross River (southern)—mouth of—see Schroeder.

Daniels Lake (T 65 N, R 1 W); Devil's Track Lake (T 62 N, R 1 W); Devil's Track River—mouth of (T 61 N, R 1 E).

East Bearskin Lake (T 64 N, R 1 E); East Pike Lake (T 65 N, R 3 E); East Pope Lake (T 65 N, R 2 W); Elbow Lake (T 62 N, R 1 E).

Fort Charlotte (T 64 N, R 5 E); Fowl Portage—see Cock Portage.

Gaskin Lake (T 64 N, R 2 W); Governor('s) Island—see Susie Island; Grand Marais (T 61 N, R 1 E); Grand Portage (settlement) (T 63 N, R 5 E); Grand Portage Bay (T 63 N, R 5 E); Grand Portage Island (T 63 N, R 5 E); Granite River (T 66 N, R 4 W); Great New Portage—Rove Lake to Rose Lake; Greenwood Lake (T 64 N, R 2 E); Gunflint Lake (T 65 N, R 2 & 3 W); Gunflint Trail—road running north out of Grand Marais.

Hat Point (T 63 N, R 5 E); High Island—see Lucille Island; High Falls (of the Pigeon River) (T 64 N, R 7 E); Horseshoe Lake (T 64 N, R 1 W); Hovland (T 62 N, R 4 E); Hungry Jack Lake (T 64 N, R 1 E).

Jasper Lake (T 65 N, R 5 W); John Lake (T 65 N, R 3 E).

Kadunce Creek—mouth of (T 61 N, R 3 E); Kelso Lake (T 63 N, R 5 W); Kelso Mt. (T 63 N, R 5 W); Kelso River (T 63 N, R 4 W); Kimball Creek—mouth of (T 61 N, R 3 E); Kimball Lake (T 62 N, R 3 E).

Leo Lake (T 64 N, R 1 W); Lily Lake (T 65 N, R 2 E); Lima Mt. (T 64 N, R 1 W); Little Brick Island (T 63 N, R 7 E); Little Caribou Lake (T 65 N, R 1 E); Little Cherry Portage—Lily Lake to Mountain Lake; Little Mississippi (T 62 N, R 2 W); Lize Lake (T 64 N, R 1 W); Long Island (T 63 N, R 7 E); Long Lake (T 62 N, R 3 W); Loon Lake (T 65 N, R 3 W); Lucille Island (T 63 N, R 7 E); Lutsen (T 60 N, R 3 W).

McFarland Lake (T 64 N, R 3 E); Magnet Island—see Belle Rose Island; Mark Creek (T 61 N, R 2 W); Mark's Bay—see Clark's Bay; Martin & Perch Portage—Rose Lake to South Lake; Mineral Center (T 63 N, R 5 E); Moose Lake (T 65 N, R 3 E); Moose Portage—North Fowl Lake to Moose Lake; Morrison's Bay (T 64 N, R 7 E); Moss Lake (T 65 N, R 1 W); Mt. Josephine (T 64 N, R 6 E); Mt. Maud (T 63 N, R 5 E); Mt. Rose (T 63 N, R 6 E); Mountain Lake (T 65 N, R 2 E); Mud Lake—see Rose Lake.

North Lake (T 65 N, R 2 W); North Fowl Lake (T 65 N, R 3 E); Northern Light Lake (T 63 N, R 2 E).

Onion Mt. (T 59 N, R 4 W); Otter Lake (near South Lake) (T 65 N, R 1 W); Otter Lake (T 64 N, R 3 E).

Partridge Falls (T 64 N, R 5 E); Partridge Lake (T 65 N, R 1 W); Perch Portage—see Martin Portage; Pigeon Falls—see High Falls; Pigeon Point (T 64 N, R 7 E); Pigeon River—mouth of (T 64 N, R 7 E); Pike Lake (T 61 N, R 2 W); Pine Lake (T 65 N, R 2 E); Pope Lake (T 65 N, R 2 W); Poplar Lake (T 64 N, R 1 & 2 W); Poplar River—mouth of (T 60 N, R 3 W); Porcupine Island (T 64 N, R 7 E).

Reservation River—mouth of (T 62 N, R 5 E); Rocky Lake (T 64 N, R 1 E); Rose Lake (T 65 N, R 1 W); Rove Lake (T 65 N, R 1 E); Round Lake (T 65 N, R 4 W); Royal Lake and River (T 64 N, R 3 E).

Saganaga Lake (T 66 N, R 4 & 5 W); Sailboat Island (T 63 N, R 7 E); Sawbill Creek (T 62 N, R 4 W); Sawbill Lake (T 62 & 63 N, R 4 W); Schroeder (T 58 N, R 4 W); Sea Gull Lake (T 65 N, R 4 & 5 W); Sea Gull River (T 66 N, R 4 W); South Lake (T 65 N, R 2 W); South Fowl Lake (T 64 N, R 3 E); Split Rock Canyon of the Pigeon River (T 64 N, R 5 E); Stump Lake (T 64 N, R 2 E); Susie Island (T 63 N, R 7 E); Swamp Lake (T 64 N, R 1 W).

Temperance River (T 59 N, R 4 W); The Grand Portage—from Grand Portage to Fort Charlotte; Tofte (T 59 N, R 4 W); Tucker Lake (T 64 N, R 3 W).

Watab (Watap) Lake (T 65 N, R 1 E); Watab Portage—Mountain Lake to Watab Lake; Wauswaugoning Bay (T 64 N, R 6 E); West Bearskin Lake (T 65 N, R 1 W); West Pike Lake (T 65 N, R 2 E); Winchell Lake (T 64 N, R 2 W); Wonder Lake (T 62 N, R 5 W).

12. Annotated List of the Vascular Plants of Cook County[9]

The following conventions have been adopted in this section:

Locality—The place name of the *nearest major* geographical feature only is given in the citations of specimens. This does not always duplicate a place name on the plant label. Details of locality and habitat are omitted for individual collections. The order in which the major geographical localities are listed is first from west to east in the region of the Border Lakes to Pigeon Point, then from east to west for the areas adjacent to Lake Superior. *cf.* Map of Cook County, Figure I, and Gazetteer in Section 11, preceding.

Collector—If a collector has made a collection of appreciable size this is listed in the Table of Section 10; the collector is then referred to by the identifying initials there indicated.

Location of the specimens cited—Unless otherwise indicated, a sheet of each of the specimens cited is deposited in the Herbarium of the University of Minnesota.

Order of arrangement of the plant names—With rare exceptions, this follows the order in Gray's Manual, ed. 8.

Acknowledgements—The writers are deeply indebted to all those who have been cited in the main body of this section for lending their judgement to the clarification of some of the problems in identification that have arisen over the past decade and a half.

In addition the junior author would like to acknowledge his debt to the late Mr. C. A. Weatherby for checking and re-writing the Latin description of *Lycopodium* × *Buttersii*, and to his friend Dr. R. C. Foster of the Gray Herbarium for performing the same service for the balance of the Latin descriptions.

EQUISETACEAE

Equisetum arvense L. (typical). Grand Portage, Be 580.—Shore of Lake Superior.

E. arvense, var. boreale (Bong.) Ledeb. Grand Portage, R 6010.—Shady woods.

E. pratense Ehrh. Grand Portage, Be 581.—Edge of road.

E. sylvaticum L., var. pauciramosum Milde, f. multiramosum

[9] Many of the records indicated as new in this section were made available over the years to Prof. M. L. Fernald while he was preparing the eighth edition of Gray's Manual; therefore many of them have already been published there.

Fernald, Rhodora **20:** 131. Poplar Lake, D 6; Grand Portage, Be 701; Hovland, BR 4624.—Wet woods and roadside ditches; ubiquitous.

E. palustre L. Grand Portage, BM 10878.—Spruce-tamarack swamp. We find that our material has ovate-lanceolate teeth with wide borders, corresponding to Marie-Victorin's illustration (Contrib. Lab. Bot. Univ. Montreal, no. 9: p. 55. 1927) of the European type. Therefore we are not applying to this material his name, var. *americanum*, for the usual North American material.

E. fluviatile L. (typical). Clearwater Lake, SS 6021; Mountain Lake, BB1 441; Poplar Lake, BA (sight record); Belle Rose Island, OS 1063; Long Island, OS 1111.—Lake shores; fairly abundant wherever suitable shallow-water habitats occur, which are not as common as farther south in the state.

E. fluviatile, f. linnaeanum (Döll) Broun, Index to N. A. Ferns, p. 87. 1938. Loon Lake, D 160; Rove Lake, BA 111; Tofte, L 6338; Schroeder, L 6415, SS (6–26–48).—Shallow water of lakes and roadside ditches; local because many lakes of the region are deep right up to the shore.

E. hyemale L., var. affine (Engelm.) A. A. Eaton. Cross River, BA 930; Grand Portage, Be 522.—Old portage trail.

E. variegatum Schleich. Schroeder, SS 12015, OO 994.—"Ditch along roadside."

This is typical, according to Gray's Manual, ed. 8 (p. 9), having sheathes slightly broadened upward and cone but 6 mm. or less long. Also collected by R. M. Schuster (12035a) on dripping ledges, Lower Falls, Gooseberry River in Lake County.

E. scirpoides Michx. Susie Island, OS 1084, OO 1131; Grand Marais, H. L. Lyon 929; Cascade River, D. Bierhorst (Sept. 10–11, 1952).—Mossy bog, Thuja woods; rare.

Interestingly enough this is locally very abundant somewhat further east along the North Shore.

LYCOPODIACEAE

Lycopodium Selago L. (typical). Clearwater Lake, BA 84 (in part, *fide* R. M. Tryon), BA 94a; Pigeon Point, S 6003; Susie Island, OO 1152; Schroeder, OS 983a.—Shaded cliffs and moist slopes.

This phase with the appressed leaves is rare.

L. Selago, var. patens (Beauv.) Desv. *cf.* Wilson, Rhodora **34:** 169–172 and **36:** 13–19. Rove Lake BBsH 111; Clearwater Lake, BBl 466, BA 84, BA 94b; Alder Lake, BsH 384; Mountain Lake, BAA 246, BBsH 29, BBsH 59, BBsH 65; Clark's Bay, BAA 403; Porcupine Island, OO 1057; Belle Rose Island, OO 1067; Lucille Island, BAA 376; Long Island, OS 1115; Grand Portage BR 6296; Schroeder, OS 983b.—Cliffs, moist woods, cedar swamps, talus slopes; fairly frequent especially on talus slopes.

A collection made by R. M. Schuster (s. n., Sept. 4, 1947), as well as part of Butters and Abbe 84, is intermediate between typical *L. Selago* and its var. *patens* according to R. M. Tryon.

L. LUCIDULUM Michx. North Lake, MacMillan Brand & Lyon 136; South Lake, BA 790; Clearwater Lake, BBl 446; Mountain Lake, BBsH 148; Macfarland Lake, BsH 367; Royal Lake, BsH 235, BsH 329; Clark's Bay 6221; Grand Portage, R 6011; Brule River, BR 4533; Devil's Track River, C. W. Hall (Aug. 21, 1879); Carlton Peak, T. S. Roberts (Aug. 25, 1879); Schroeder, OS 983c.—Cliffs, woods, swamps; fairly frequent.

In addition to the spore characters mentioned by Wilson (*loc. cit.*) there are two other categories of rather minute characters which may be found useful in distinguishing *L. Selago* (and its vars.) from *L. lucidulum.* These have the advantage over the spore characters of being applicable to sterile material.

Stomata:—present on both surfaces of the leaf of *L. Selago* (and its vars.), although more abundant on the abaxial surface.
—present only on the abaxial surface in *L. lucidulum.*

This difference is visible under the higher powers of the dissecting microscope, so that it is not necessary to try to dissect off the epidermis.

Scales of propagative bulbils:
—the larger scales are acute or acutish at apex in *L. Selago.*
—they are rounded or obtuse with a slight apiculation in *L. lucidulum.*

L. × Buttersii Abbe[10] hybr. nov.—*L. lucidulum* × *L. Selago*, var. *patens.*—Cliffs; very rare.

Lycopodium × Buttersii occurs, as far as the collections of the Herbarium of the University of Minnesota indicate, only in Lake and Cook counties. The records show that it is often found in association with the putative parents.

The following table summarizes respects in which it is intermediate between *L. lucidulum* and *L. Selago*, var. *patens:*

[10] Rami fertiles 15–35 cm. longi; folia lineari-attenuata vel paullum lineari-oblanceolata, paginis ambobus stomatibus instructa, fere integra vel sparse minuteque denticulata, in gemma adpressa, tum patentia, demum reflexa; zona foliarum breviorum alterna zona foliarum longiorum; bulbilli obtusiusculae (eis parentum mediae); caules fructiferi 1- vel 2-furcati; spori magnitudine figuraque valde variabiles, plerique abortivi. Typus: Butters, Burns & Hendrickson 111a (Herb. Univ. Minn.).

Tall, 15–35 cm. long (fruiting stems); leaves linear-tapering to slightly linear-oblanceolate with stomata on both surfaces, nearly entire but with occasional minute denticulations, appressed in bud, then spreading, and eventually reflexed; a zone of short leaves alternating with a zone of long ones, but not rendering the shoot conspicuously moniliform; bulbils slightly obtuse (about intermediate between those of the parents); fruiting stems once or twice forked; spores very variable in size and shape, many of them abortive.

Minnesota: *Lake County;* in spruce-balsam bog on roadside, Ely-Finland road, Aug. 27, 1937, *F. K. Butters and C. Rosendahl 6881;* mossy cliffside at Baptism River, Aug. 10, 1944, *Olga Lakela 5681; Cook County;* cliff south of outlet of Rove Lake, July 11, 1938, *Butters, Burns and Hendrickson 96;* cliff south of Rove Lake, July 11, 1938, *Butters, Burns and Hendrickson* 111a (TYPE); in deep, moist, swampy coniferous forest in center of Pigeon Point beyond Clark's Bay, Sept. 5, 1947, *R. M. Schuster 6005.*

	L. lucidulum	*L. × Buttersii*	*L. Selago* var. *patens*
Shoot	moniliform	slightly moniliform	cylindrical
Leaves			
—shape	linear-oblanceolate	intermediate	linear-tapering
—margins	denticulate	intermediate	entire
—stomata	below only	both surfaces	both surfaces, more below
Bulbils, (large scales)	rounded to obtuse, slightly apiculate	intermediate	acute or acutish

The characters of this hybrid were carefully worked out by Dr. Butters during the period prior to his death; the junior author therefore has taken the liberty of naming it for Dr. Butters.

L. annotinum L. (typical). Sea Gull Lake, L 3647; Gunflint Lake, SS 6015 (*fide* Tryon); Hungry Jack Lake, BR 6347; Poplar Lake, D 69 (*fide* Tryon); Rove Lake, BBsH 93; Clearwater Lake, BA 95; Royal Lake, BsH 271; Pigeon Point, N 1644, S 6006 (*fide* Tryon); Clark's Bay, BR 6220; Belle Rose Island, BR 6235; Lucille Island, BAA 384; Grand Portage, Be 550, SS 6053 (*fide* Tryon); Brule River, BR 4550; Temperance River, SS 6033 (*fide* Tryon).—Cliffs and woods; very abundant.

L. annotinum, var. acrifolium Fernald, Rhodora **17:** 124. Mountain Lake, BBsH 20; Grand Marais, MacMillan Brand & Lyon 60.—Trails, etc.

R. M. Tryon assigns the above collections to var. *pungens* "tending toward typical."

L. annotinum, var. pungens (La Pyl.) Desv. Clark's Bay, BR 6248; Lucille Island, BR 6232; Grand Portage, Be 673; Hovland, OS 1006.—Swamps and shore rocks.

L. clavatum L. *sens. lat.* Mineral Center, Be 644; Temperance River, Lakela 5698, SS 6032, OO 997.

R. M. Tryon would assign the collections listed under the following two varieties to typical *L. clavatum.*

L. clavatum, var. laurentianum Vict. Sawbill Lake, Bg 121; South Lake, BA 809a, BA 809b; Poplar Lake, BR 6368; Clearwater Lake, BBl 447; Lima Mountain, BA 886; Clark's Bay, BR 6222; Belle Rose Island, BR 6236.—Woods.

Included under this variety are collections (BBl 447, BR 6222) which could be referred to Victorin's var. *subremotum.* However this so-called variety is better considered a luxuriant phase of var. *laurentianum,* because both may appear on one and the same plant.

L. clavatum, var. megastachyon Fernald & Bissell, Rhodora **12:** 53. Sea Gull Lake, BBl 395; Poplar Lake, BR 6369; Hungry Jack Lake, BR 6346; Clearwater Lake, BBl 445, N 1694; Lima Mountain, BA 885.—Woods; abundant.

L. obscurum L. (typical). Mountain Lake, BBsH 132.—Woods; very rare in Minnesota.

An intermediate form with flattened twigs, but mostly without short ventral leaves is represented by the following: Royal Lake, BM 10849; Grand Portage, Be 546; Mineral Center, Be 674. R. M. Tryon assigns these specimens to var. *dendroideum* with "some tendency toward typical."

L. OBSCURUM, var. DENDROIDEUM (Michx.) D. C. Eaton. Sawbill Lake, Bg 120; Poplar Lake, L. W. Orr 5, L. A. Koelnau 113, D 34; Clearwater Lake, BBl 444; East Pike Lake, BsH 214; Pigeon Point, N 1624; Susie Island, R (Aug. 15, 1929), OO 1023; Devil's Track Lake, E. Loula 20; Cascade River, Roberts (no no., no date).—Talus slopes and woods; very abundant in Cook Co.

BBl 444 may be referred to Victorin's f. *exsertum*.

L. COMPLANATUM L. (typical). Sawbill Lake, Bg 119; Poplar Lake, BR (Aug. 25, 1934), D 50d; Birch Lake, D 57; Clearwater Lake, BBl 454; Susie Island, OO 1045; Hovland, SS 6071.—Woods; very rare in the state.

Although the rest of our collections of this species are cited to variety, there is considerable question as to whether the characters are sufficiently strong to justify taxonomic segregation. However, the writers have found no organic connection between plants bearing the characteristics of these varieties although the plants grow intermixed.

R. M. Tryon assigns the specimens cited under the two following varieties to typical.

L. COMPLANATUM, var. CANADENSE Vict. Watab Lake, BA 120a, BBsH 17; Clearwater Lake, BBl 456; Clark's Bay, BR 6252; Susie Island, R 6035c.—Woods.

L. COMPLANATUM, var. ELONGATUM Vict. Poplar Lake, BR (Aug. 25, 1934, rhizome 2 inches deep), BR (Aug. 23, 1934, rhizome 8–10 inches deep); Watab Lake, BBsH 16; Caribou Lake, BsH 398; Mountain Lake, BBsH 26; Grand Marais, H. L. Lyon 929.—Woods; the most abundant of the varieties. Most of the specimens have rather deep-seated rhizomes, but may vary in this respect even in the same plant.

L. TRISTACHYUM Pursh (*cf.* Clausen, Amer. Fern Journ. 35: 9–20). Susie Island, R 6035b.—On rocks.

This is a sterile specimen, but it is almost certainly this species. Specimens from this state previously identified as this species are *L. complanatum*, var. *elongatum*.

SELAGINELLACEAE

SELAGINELLA SELAGINOIDES (L.) Link. Brick Island, OS 1076; Susie Island, S (Sept. 6, 1947), OO 1119; Long Island, AA 508, S (Sept. 5, 1947); Sailboat Island, S 11751 (with *Leiocolea gillmani*); Grand Marais, L. S. Cheney (Jul. 26, 1891).—In moist moss and soil in cracks in rocks; very rare. These are the only collections from Minnesota represented in the Herbarium of the University of Minnesota. It is relatively abundant in similar habitats in the Thunder Bay District of Ontario.

S. RUPESTRIS (L.) Spring. Caribou Lake, BsH 400; Mountain Lake, BAA 255, S (July 11, 1947); John Lake, BM 10790; South Fowl Lake, BsH 319; Clark's Bay, BR 6225, BAA 398; Wauswaugoning Bay, R

6056; Mount Josephine, BR 6310, BA 172, BA 1044, SS 6001; Mt. Rose, SS 6068; Mineral Center, BR 4564.—Dry, exposed rocks on cliffs and hill-tops; general.

ISOËTACEAE

Isoëtes muricata Dur. Gunflint Lake, BR 6384; South Lake, MacMillan Brand & Lyon 146; Poplar Lake, BA 775; Birch Lake, BA 814; Rose Lake, MacMillan Brand & Lyon 170 & 198; Hungry Jack Lake, BR 6353; Rove Lake, MacMillan Brand & Lyon 171; Northern Light Lake, MacMillan Brand & Lyon 71; Mountain Lake, MacMillan Brand & Lyon 177; Brule River, C. B. Reif A3, C. B. Reif A22; Temperance River, C. B. Reif A14.—Same habitats as *I. macrospora;* apparently fairly frequent.

I. macrospora Dur. Partridge Lake, BA 815; Birch Lake, BA 814a; Hungry Jack Lake, MacMillan Brand & Lyon 99; Devil's Track Lake, MacMillan Brand & Lyon (Aug. 28, 1901).—Local in occasional shallows of some lakes and slow streams; apparently infrequent.

OPHIOGLOSSACEAE

Botrychium multifidum (Gmel.) Rupr. Mountain Lake, BBsH 33; Mount Josephine, BR 6325; Grand Marais, MacMillan Brand & Lyon 45.—Dry woods; infrequent. BR 6325 is assigned by R. M. Tryon to *B. multifidum* var. *intermedium.*

B. multifidum, var. intermedium (D. C. Eaton) Farwell. John Lake, BM 10800.—Top of a bluff; apparently very uncommon.

B. Lunaria (L.) Sw. Brule River, L. S. Cheney (Jul. 2, 1891).

B. Lunaria, f. **onondagense** (Underw.) comb. nov. *B. onondagense* Underw. Bull. Torr. Bot. Cl. 30: 47. 1903. Grand Portage, BM 10866; Grand Marais, C. J. Hibbard (Jul. 25, 1902), H. L. Lyon (Aug. 16, 1906).—Moist woods; rare.

During the academic year 1916–17 the senior author, while at the Gray Herbarium, pencilled the following comment on a sheet of this variety collected by Williams, Collins and Fernald, July 8, 1905:—

"This seems to be exactly the same form as to shoot which Underwood described as *B. onondagense* from the vicinity of Syracuse, N. Y. It appears to be merely a shade form of *B. Lunaria.* Similar leaflets occur also in material from British Columbia, and also in Swiss material (*vide* A. S. Pease, no. 9274, Schya Pass).

The short root axis which is described for *B. onondagense* is often found in *B. Lunaria* from various sources.

F. K. B."

There seems to be no good reason to change this viewpoint and we therefore suggest that it be treated as a form. The combination is commonly attributed to Clute (Our Ferns, pp. 76 and 384, 1938) but it has not been made in a valid fashion.

B. simplex E. Hitchc. *sens. lat.* Lima Mountain, BA 862½; Temperance River, R. M. Schuster A5409.—"Moist, springy side of marly ditch

along road." BA 862½ was detected by R. M. Tryon in a collection of *B. matricariaefolium* and was assigned by him to *B. simplex*, var. *laxifolium* Clausen.

B. MATRICARIAEFOLIUM A. Braun. Lima Mountain, BA 862; Temperance River, SS 6041.—Moist woods; rare.

B. VIRGINIANUM (L.) Sw., *sens. lat.* Sea Gull Lake, L 3627; Wauswaugoning Bay, NE 2325 (too young for identification as to variety).—Shady woods.

B. VIRGINIANUM (typical) *cf.* Butters, RHODORA **19:** 207. John Lake, BsH 268; Mount Josephine, BA 1052; Schroeder, BA 1060.—Wet woods; scattered and infrequent. BsH 268 is considered transitional to var. *europaeum* by R. M. Tryon.

B. VIRGINIANUM, var. INTERMEDIUM Butters, RHODORA **19:** 210. Clearwater Lake, BA 67; Mountain Lake, BAA 301, BBsH 151; East Pike Lake, BsH 208a; Royal Lake, BM 10855; Pigeon River, BR 4615; Grand Portage, BM 10880; Mount Josephine, BA 181; Mineral Center, BR 4593.—Moist woods; occasional. BA 181, BAA 301, BBsH 151, BsH 208a, BM 10880, BM 10855 are assigned by R. M. Tryon to typical *B. virginianum*.

B. VIRGINIANUM, var. EUROPAEUM Ångstr. Gunflint Lake, R 5455; West Pike Lake, BsH 206; Grand Portage, R 6291; Grand Marais, H. L. Lyon 934.—Moist woods; occasional.

OSMUNDACEAE

OSMUNDA REGALIS L., var. SPECTABILIS (Willd.) A. Gray. Sea Gull Lake, N 1732, L 3605; Cross River, BBl 394; Horseshoe Lake, BA 131; Royal River, BsH 343; Brule River, BR 4537; Devil's Track River, T. S. Roberts (Aug. 18, 1879).—Lake shores, river margins, dank woods, rarely in shallow water; occasional. BA 131 is unique in that the whole colony from which this collection was made was growing in several inches of water.

O. CLAYTONIANA L. Watab Lake, BAA 319; Royal River, BsH 364.—Moist woods; fairly abundant (more so than the number of collections indicates).

O. CINNAMOMEA L. Between Birch and Poplar Lakes, BA 820.—Sphagnum swamp; infrequent.

POLYPODIACEAE

WOODSIA ILVENSIS (L.) R. Br. Lake Saganaga, N. L. Huff (Aug. 23, 1941); Moss Lake, D 139; Winchell Lake, BA 140a; Watab Lake, BAA 244b; Clearwater Lake, BBl 461, BA 56, BA 213, D 115; Little Caribou Lake, BsH 426; Mountain Lake, BAA 275; MacFarland Lake, BBl 330; Royal Lake, BsH 236; Pigeon Point, N 1632, BA 1001; Porcupine Island, AA 583; Susie Island, B (Sept. 1, 1927), AA 565, OO 1044; Lucille Island, BR 6233, N 1657; Sailboat Island, OO 1101; Grand Portage, R (Aug. 14, 1929), BR 621, BA 154, SS 6057, SS 6058; Grand Portage Island, R 6027; Mount Josephine, BR 6309; Kimball Creek, R 2608; Grand Marais, R

(Aug. 9, 1927); Carribeau River, BR 4494; Temperance River, L 4790; Thunder Bay Dist., Ont. (Pigeon Bay), AA 609, AA 609a.—Ubiquitous on eruptive and metamorphic rocks; along with *Polypodium virginianum* the most abundant fern of the region.

The collections listed above vary widely in the amount of chaffiness. The typically chaffy plants (for instance, BA 56, BsH 426, AA 583, BR 6233, AA 609) are the most common throughout the region. Rarely a collection (BAA 275) will range from extremely chaffy to relatively glabrous. There are relatively glabrous phases, approaching *W. alpina* (for instance, BA 140a, BBl 461, BR 4494, AA 609a) which are considerably less frequent than the typically chaffy phase. It may well be that this relatively glabrous phase is a naturally occurring backcross of *W.* × *gracilis* to *W. ilvensis* (*cf.* remarks below under *W.* × *gracilis*). This relatively glabrous phase may also be interpreted as ecological. Whether either or both interpretations may be correct can be determined only by actual experiment with a group of ferns which are apparently difficult to grow in cultivation.

W. alpina (Bolt.) S. F. Gray (typical) *W. Belli* (Lawson) A. E. Porsild, Rhodora **47:** 147. 1945. Clearwater Lake, BBl 397, BBl 458, BBl 459, BA 96, BBsH 5, SS 6018; Mountain Lake, BBsH 126a; Pigeon Point, BA 998; Devil's Track River, BR 4641; Poplar River, BR 4697; Temperance River, L 4789, SS 6040.—Damp shady cliffs and canyons; very rare. Local and extremely scarce; apparently restricted to regions of basic rock.

The above-mentioned specimens are typical, and except for collections made at the Gooseberry River and Manitou River in adjacent Lake County, are the only records for the state as represented in the Herbarium of the University of Minnesota.

W. × gracilis (Lawson) Butters, Amer. Fern Jour. **31:** 15. (*W. alpina* × *W. ilvensis*) *W. ilvensis*, var. *gracilis* Lawson. Watab Lake, BAA 244a, BBl 397a, BBsH 5a; Mountain Lake, BAA 275, BBsH 126; Pigeon Point, AA 591, BA 999; Grand Portage, BA 153, BM 10884.—Cliffs; local.

For a more general discussion, see Butters (*loc. cit.*). Several of the above were found in intimate association with the presumed parents. At any one station there are usually more plants of the hybrid than of *W. alpina*.

This hybrid is prevailingly sterile, but occasional sporangia will mature and then contain spores which are usually malformed. It is conceivable that occasional spores may be viable. In this case there occurs the possibility of a backcross to the very common *W. ilvensis*. The least chaffy specimens referred to under *W. ilvensis* may possibly have this origin; they are, however, normally fertile. R. M. Tryon has annotated BM 10884 and BAA 275 as "*Woodsia ilvensis* (L.) R. Br."

W. glabella R. Br. Pigeon Point, AA 589, BA 1002; Grand Portage, B (Sept. 14, 1929), BR 6207, BBl 365, BA 152, SS 6055.—Moist, slate cliffs; extremely local and rare. The old reference in Upham (Geol. Nat. Hist. Surv. Minn., Ann. Rept. 1883, Pt. VI) to a station for this species

at Stillwater in southeastern Minnesota is spurious, being based on a sterile specimen of that ubiquitous ferny weed *Cystopteris fragilis*. It is otherwise represented from Minnesota only by R. M. and O. M. Schuster 6076 collected on rock outcrops, Gooseberry River in Lake County.

W. Cathcartiana B. L. Robinson, Rhodora **10:** 30. John Lake, BM 10787, BM 10793, BM 10795; Grand Portage, R 6064a, Butters & Wherry (June 29, 1935), BA 151.—Moist slate talus below cliffs; local, but abundant at a few stations.

W. × Abbeae Butters, Amer. Fern Jour. **31:** 18. *W. Cathcartiana* × *W. ilvensis*. John Lake, BM 10785; Grand Portage, BBs 713½; Thunder Bay District, Ont. (Pigeon Bay), AA 596.—Cliffs; rare. This is discussed in more detail in Butters (*loc. cit.*).

W. scopulina D. C. Eaton. Rove Lake, BBsH 109; Clearwater Lake, BBl 418, BBl 455, Butters & Wherry (June 29, 1935), BA 123, Butters & Abbe (June 21, 1936); Alder Lake, BsH 389; Mountain Lake, BAA 278, BAA 281, BBsH 85, BBsH 119, BBsH 137; West Pike Lake, BsH 164, BsH 180; East Pike Lake, BsH 231; MacFarland Lake, BsH 370; North Fowl Lake, BABs 654; South Fowl Lake, BsH 311, BM 10830; Royal Lake, BsH 255, BsH 341, BsH 355, BM 10847; Pigeon Point, BA 1000, BA 1005; Grand Portage, R 6064b, BR 6209, BR 6218, BBl 418, Butters & Wherry (June 30, 1935), BA 148, B (Jul. 14, 1937), SS 6054; Mount Rose, S 6002; Thunder Bay Dist., Ont. (Pigeon Bay), AA 610.—Moist cliffs; throughout the Rove Slate region, extremely localized—very abundant on some cliffs, rare on others, and absent from many.

The collections cited above fill in another gap in the east-west distribution of a species notably disjunct in the eastern portion of its geographic area.

Cystopteris fragilis (L.) Bernh. (typical). *cf.* Weatherby, Rhodora **37:** 375. Moss Lake, D 147; Clearwater Lake, BBl 464, BA 53, BA 120, BsH 164a; Mountain Lake, BBsH 51, BBsH 53; East Pike Lake, BsH 220; John Lake, BM 10794; MacFarland Lake, BBl 332; Royal Lake, BsH 244, BsH 330; Pigeon Point, BA 1006; Grand Portage, R 6027a, B (Sept. 14, 1929), BR 6210; Brule River, BR 4546, BR 4547, BR 4548; Carribeau River, BR 4501; Poplar River, BR 4697a.—Moist cliffs, etc.; ubiquitous.

C. fragilis, var. laurentiana Weatherby, Rhodora **28:** 130. Cascade River, T. S. Roberts (Aug. 2, 1879).—Apparently very rare.

C. fragilis, var. Mackayii Lawson. Clearwater Lake, D 114; Mountain Lake, BBsH 121; Royal Lake, BM 10845.—Moist cliffs; rare.

R. M. Tryon has annotated BM 10845 and BBsH 121 as intermediate between *Cystopteris fragilis* (typical) and var. *Mackayii*.

Pteretis pensylvanica (Willd.) Fern. (typical). West Pike Lake, BsH 189.—Moist woods, often along small streams; common.

P. pensylvanica, f. pubescens (Terry) Fern., Rhodora **47:** 124. Mountain Lake, BBsH 149; Grand Portage, BR 6334; Mineral Center, BA 195; Kimball Creek, BR 4667.—Moist woods; common.

Onoclea sensibilis L. Cross River, BBl 393; Hungry Jack Lake, BAA 333; Leo Lake, BR 6333; Mountain Lake, BBsH 150; Lucille

Island, BAA 369.—Low, wet woods and along roadsides; local, usually in obviously warm pockets—much more abundant further south in the state.

Dryopteris disjuncta (Ledeb.) C. V. Morton, Rhodora **43:** 217. *D. Linnaeana* C. Chr. Sea Gull Lake, L 3626; Sawbill Lake, Bg 124; Poplar Lake, L. W. Orr 7, L. W. Orr 22, D 90; Watab Lake, BA 108a; Royal Lake, BsH 238; Grand Portage, Be 575; Porcupine Island, OO 1054; Susie Island, OO 1124; Grand Marais, T. S. Roberts (Jul. 31, 1879), H. W. Slack (July 1892).—Moist woods; frequent.

D. Robertiana (Hoffm.) C. Chr. Cross River, BA 900; North Lake, D. Lange 15; Poplar Lake, BA 845; Watab Lake, BAA 226, BAA 244; Clearwater Lake, BBl 460, BA 95a; Little Caribou Lake, BsH 428, BsH 429; Mountain Lake, BAA 280, BBsH 30, BBsH 125; John Lake, BM 10816; Thunder Bay Dist., Ont. (North Fowl Lake), BABs 686.—Moist wooded cliffs; frequent.

D. Phegopteris (L.) C. Chr. Gunflint Lake, BBl 374; Rove Lake, BA 107a; West Pike Lake, BsH 203; MacFarland Lake, BBl 340, BBl 343; Pigeon Point, BAA 431; Grand Portage, R 5997; Grand Marais, T. S. Roberts (Jul. 31, 1879); Tofte, R 7831.—Moist woods; frequent.

D. spinulosa (O. F. Muell.) Watt (typical). Gunflint Lake, BBl 376; Poplar Lake, L. W. Orr 8, BA 821; Rove Lake, BBl 425; Mountain Lake, BBsH 32; South Fowl Lake, BABs 629; Pigeon River, BR 4616; Grand Portage, R 6071, BR 6288; Hovland, BR 4631; Tofte, R 7849.—Swampy woods; frequent.

D. spinulosa, var. fructuosa (Gilbert) Trudell. Lucille Island, BR 6231; Grand Portage, BR 6284, BR 6285.—Swampy woods; rare. These are the only collections from Minnesota of this western and Eurasian phase. It has dark scales and obliquely ascending rhizomes. Its fronds, in our experience, may sometimes be as much as a meter in length.

D. spinulosa, var. intermedia (Muhl.) Underw. Grand Marais (10 mi. north), BA 768; Morrison Bay, BBs 714; Grand Portage, BR 6282, BR 6286, BR 6287, BR 6290; Mineral Center, BA 196.—Moist deciduous and balsam woods; infrequent. BR 6286 and 6290 combine in varying degrees the characteristics of the typical material and var. *intermedia* with respect to:—location of new growth, angle of the rhizome, glandulosity of the indusia, and size and sculpturing of the spores.

D. spinulosa, var. americana (Fisch.) Fernald, Rhodora **17:** 48. Poplar Lake, L. W. Orr 20; Mountain Lake, BAA 282; Pigeon Point, Rosendahl and Rydberg 6081; Clark's Bay, N 1621; Morrison Bay, Rosendahl and Rydberg 6051; Grand Portage, J. M. Holzinger (Aug. 11 and 12, 1902), Rosendahl and Rydberg 5984, Rosendahl and Rydberg 5991, Rosendahl and Rydberg 6033a, B (Sept. 14, 1929), BR 6283; Mineral Center, BA 197; Hovland, BR 4632.—Swampy woods; frequent. Often growing with the preceding.

D. cristata (L.) A. Gray. Sawbill Lake, Bg 123; Cross River, BA 897; Lima Mountain, BA 854; Mountain Lake, BBsH 145.—Tamarack and alder swamps; locally abundant, suitable habitats infrequent.

D. fragrans (L.) Schott, var. remotiuscula Komarov. Saganaga Lake, N. L. Huff (Aug. 23, 1941); Sea Gull Lake, L 3697; Gunflint Lake,

BBl 378; North Lake, D. Lange 16; Poplar Lake, R 5434, D 89, D 97; Watab Lake, BAA 245; Clearwater Lake, Butters & Wherry (1935), BA 57, BA 214; Little Caribou Lake, BsH 430; Mountain Lake, BAA 275; MacFarland Lake, BBl 331; Pigeon River, L. S. Cheney (Jul. 6, 1891), BR 4622; Pigeon Point, BAA 432; Belle Rose Island, BR 6240, OO 1059; Susie Island, BBl 371; Lucille Island, N 1658, BAA 379; Grand Portage, R 6067, BR 6208, R 7866, SS 6059; Hovland, SS 6073; Brule River, BR 4542.—Rocks and cliffs; abundant.

Athyrium angustum (Willd.) Presl, *sens. lat.* *A. Filix-femina* (L.) Roth, var. *Michauxii* (Spreng.) Farw. Clearwater Lake, BBl 448, BBl 449; Grand Portage, R 7888; Porcupine Island, AA 581, BBs 746; Sailboat Island, OO 1100; Carribeau River, BR 4500; Tofte, R 7830.

Very commonly plants from the cold shore of Lake Superior, or places where the soil is limited, do not develop well and therefore cannot be determined to variety.

A. angustum, f. typicum Butters, Rhodora **19:** 191. Pigeon Point N 1643; Porcupine Island, BR 6255; Long Island, AA 549; Grand Marais, T. S. Roberts (Aug. 14, 1879).—Rocks along the shore of Lake Superior and more or less throughout Cook County.

A. angustum, var. elatius (Link) Butters, Rhodora **19:** 191. *A. Filix-femina*, var. *Michauxii*, f. *elatius* (Link) Clute. Grand Portage, Be 514.—Everywhere in moist places in woods; very abundant.

Intermediate between f. *typicum* and var. *elatius*, is a collection from Grand Marais (T. S. Roberts, July 31, 1879).

A. angustum, var. rubellum (Gilbert) Butters, Rhodora **19:** 193. *A. Filix-femina*, var. *Michauxii*, f. *rubellum* (Gilbert) Farw. Sawbill Lake, Bg 122; Greenwood Lake, E. Loula 24; Lucille Island, N 1656; Devil's Track River, BR 4640; Grand Marais, R 5957.—Crevices in shore rocks and in wet places in forest; less abundant than the preceding varieties.

Asplenium Trichomanes L. Mountain Lake, BBsH 136; East Pike Lake, BsH 228; John Lake, BM 10798; Royal Lake, BsH 250, BsH 333.—Moist, east-facing cliffs; very local, but abundant and luxuriant where it occurs.

Previously known in Minnesota, according to records in the Herbarium of the University of Minnesota, by the one collection from Vasa, Goodhue County (s. e. Minn.) made by N. L. T. Nelson in 1894, but it has not been found recently in that region of dolomites and sandstones. It is reported from Taylor's Falls (Miss Cathcart) and from Lake City (Mrs. Ray) by Upham (Geol. Nat. Hist. Surv. Minn., Ann. Rept. 1883, pt. VI). It is apparently limited to the extreme eastern edge of the state, in spite of Upham's comment that it occurs "throughout the state." The species has a curious distribution, occurring in many states to the east and south and in Manitoba, but not to the west until the coast is reached.

There seems to be no appreciable difference between American and European specimens, except that the walls of the cells in the scales are perhaps a little more yellow in the European plants. According to Gray's

Manual (ed. 8) the fronds are said to vary from 0.8 to 2.2 dm. in length—in our material they range from 0.4 to 2.5 dm. Pinnae may be up to 8 mm. in length, while the smallest are 2 mm. in length (in the central part of the frond).

Cryptogramma Stelleri (S. G. Gmel.) Prantl. Royal Lake, BM 10859; Pigeon Point, BA 997; Grand Portage, B (Sept. 14, 1929) BR 6206, BBl 364, BA 150, SS 6056, R 7873; Thunder Bay Dist., Ont. (North Fowl Lake), BABs 707.—Moist slate cliffs; rare and local. This species also occurs in the southern part of the state, and there also it is restricted to calcareous rocks. It is one of the strictest calciphiles that we have among ferns.

Pteridium aquilinum (L.) Kuhn, var. latiusculum (Desv.) Underw. ex Heller *cf.* Tryon, Rhodora **43:** 41. Rove Lake, BA (June 23, 1936).—Moderately dry woods; ubiquitous.

Polypodium virginianum L. Birch Lake, D 71; Poplar Lake, D 15, D 98, D 106; Rove Lake, BBsH 94; Clearwater Lake, BBl 470; Little Caribou Lake, BsH 427; Mountain Lake, BAA 240; Pigeon Point, R 6079, N 1634; Susie Island, B (Sept. 2, 1927); Grand Portage, R 6068, Be 629, BA 155; Mineral Center, BR 4563; Grand Marais, T. S. Roberts (Jul. 28, 1879); Temperance River, L 4788.—Extremely abundant especially on large talus blocks at the foot of cliffs throughout the region. The number of collections of this ubiquitous fern gives no indication of its great abundance. The rhizomes are usually in moss and *Cladonia*, very little soil being present. It grows to great size in these habitats, a number of the specimens collected having fronds up to 37 cm. long.

Some of the very large specimens seem to have the sori less marginal than is common with *P. virginianum*, but the appearance of rhizomes and of the scales, and the taste of the rootstocks, all identify it with this species. There is no indication of the occurrence in Cook County of any of the western varieties of *P. vulgare.*

TAXACEAE

Taxus canadensis Marsh. Lake Saganaga, N 1673; Gunflint Lake, BR (Aug. 1934); Partridge Lake, BA 816; Poplar Lake, D 25; Winchell Lake, BA 139; Clearwater Lake, BA 88; Mountain Lake, BAA 273; MacFarland Lake, BBl 336; Pigeon Point, N 1625; Susie Island, OO 1128; Lucille Island, BR 6234; Mineral Center, Be 677; Kimball Creek, R 2622.—Moist woods, talus slopes, shore rocks; rather local.

PINACEAE

Abies balsamea (L.) Mill. Sea Gull Lake, L 3631; Belle Rose Island, OO 1061; Lucille Island, BAA 377; Grand Portage, Be 642.—Abundant throughout the region in all sorts of habitats.

Picea glauca (Moench) Voss. *P. canadensis* (Mill.) BSP. Poplar Lake, BA 833.—Abundant.

P. mariana (Mill.) BSP. Poplar Lake, BA 842; Porcupine Island, BBs 743; Lucille Island, BAA 378.—Abundant throughout the region, not restricted to swamps.

Larix laricina (DuRoi) Koch. Otter Lake, BA 794; Belle Rose Island, OO 1069; Sailboat Island, OO 1099; Grand Portage, Be 613.—Rather infrequent in much of the county, possibly as a result of a severe infestation with a bud-worm some years ago. It is much more frequent in the granite country between Gunflint Lake and Lake Saganaga, where it occurs in quite extensive swamps, sometimes with but little spruce. It is, however, not confined to swamps as is almost always the case farther south in the state.

Pinus Strobus L. Lima Mountain, BA 871; Sailboat Island, AA 555.—Abundant (and formerly much more so) throughout the region in appropriate locations.

P. resinosa Ait. Clearwater Lake, BA 65; Sailboat Island, AA 556; Grand Portage, BR 6320.—Rather scarce throughout the region—less frequent in Cook Co. than elsewhere in the state, and in Cook Co. occurs primarily on well-drained morainic soils.

P. Banksiana Lam. Sailboat Island, AA 554.—Very abundant in central part of the county and in granitic area toward Lake Saganaga; and less frequent elsewhere in the county. Mostly on dry sterile soils.

Thuja occidentalis L. Birch Lake, BA 800; Clearwater Lake, BBl 473, N 1712; Grand Portage, Be 490, BR 6312.—Often in moderately dry locations, not being confined to swamps by any means; common throughout the region.

Juniperus communis L., var. depressa Pursh. Sea Gull Lake, L 3632; West Bearskin Lake, D 143; Rove Lake, BBl 428; Clearwater Lake, BA 66; Mountain Lake, BAA 225; Pigeon Point, N 1629, BAA 423; Clark's Bay, NBr 3243; Susie Island, R 6040; Lucille Island, BAA 352; Sailboat Island, AA 553; Grand Portage, R 6028a; Mount Josephine, BR 6319 & 6327, BA 188; Onion Mountain, D. M. Stewart (sight record).—On talus slopes, rock ledges and exposed rock surfaces; abundant throughout the region. A few collections from near the immediate shores of Lake Superior approach var. *saxatilis* Pallas (var. *montana* Ait.), although this may be after all merely an ecological form.

J. horizontalis Moench. Pigeon Point, BAA 434; Clark's Bay, S 6004; Little Brick Island, AA 564; Long Island, AA 512.—Rocky shores of Lake Superior; although this species is fairly general elsewhere in the state, mostly on sand, it was observed in Cook County only on the lake shore.

(*To be continued*)

Two New Variations in Trillium.[1]—The specimens cited below are preserved in the herbarium of the Division of Botany and Plant Pathology, Science Service, Department of Agriculture, Ottawa, Canada (DAO).

TRILLIUM CERNUUM L. var. **terrae-novae** var. n. Pedunculus

[1] Contribution No. 1196. Division of Botany and Plant Pathology, Science Service, Department of Agriculture, Ottawa, Canada.

pendens 2–5 cm. Flos pendens. Sepala lanceolata, 2.0–2.5 cm long.; petala lanceolata, 2.0–2.5 cm long., 6–8 mm lat., alba, ad marginem viridula. Antherae 5–6 mm, purpureo-roseae.

Newfoundland: *I. J. Bassett 293*, west coast, near Stephenville, west side of E. Harmon Air Force Base, in wet black soil under alder brushes, June 9, 1949 (DAO, type); *I. J. Bassett 269*, eodem, June 4, 1949 (DAO); *Smith, Smith & Squires 346*, Bonavista North, "The Beaches," Brown's Beach, rich woods near beach, July 26, 1946 (DAO).

TRILLIUM ERECTUM L. f. **sessiloides** f. n. Flore sessili.

Ontario, Carleton: Beechwood, close to the cemetery gate, May 1899 (DAO, type).—Bernard Boivin, Department of Agriculture, Ottawa, Canada.

THE REPOPULATION OF INTERTIDAL TRANSECTS[1]

Elizabeth M. Fahey[2]

When bare transects are exposed in the intertidal area, populations occupy them (Fahey & Doty, 1949) until after a time they look like the surrounding "control" areas. In quest of information concerning the actual sequence leading to "climax" associations a detailed study was undertaken at Nobska Point and Woods Hole, Massachusetts. The work was initiated in July, 1947, and is still incomplete. However, since the investigation has been carried on continuously from that time it is hoped that these observations may prove of interest to the marine ecologist and be of value to future workers in the field.

A review of the literature concerning intertidal ecology presents the field worker with many enigmatic ecological problems. In comparison to the extensive publications available there are but few inferences. Lack of such logical conclusions from given data, due to short-term experimentation or for other reasons, has resulted in confusion and in many cases, for example in the matter of biotic succession, this lack has given rise to more than one school of thought. In an effort to understand better what does happen in the intertidal region and why, a long-term program of repopulation studies was outlined. It was planned to clear summer, fall, winter and spring transects in order to test the hypothesis that the first macroscopic forms to appear are

[1] This report has been taken in part from a dissertation which the author submitted to the Department of Biology of Boston University in May, 1950, in partial fulfillment of the requirements for the degree of Master of Arts.

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similar, regardless of what time of the year the strip is cleared, the assumption being that the season of the year in which the transect is denuded has little effect on the cycle of reestablishment. The data recorded could then be applied to determine whether biotic succession occurs in marine associations as suggested in the conclusions of Hewatt (1937), Kitching (1937), Moore (1939), Moore & Sproston (1940) and Scheer (1945) or merely seasonal periodicity as expounded by Shelford (1930), Pieron & Huang (1925) and McDougall (1943). It was also proposed to choose stations in different positions in relation to the movement and force of the sea to observe effects on subsequent colonization. For this reason more than one transect was denuded at each time of denuding. According to the plan, observations were to be made bi-weekly throughout the year or until a complete cycle was reached and all data were to be carefully recorded.

Nobska Point, Cape Cod, Massachusetts was chosen as the site of the experiments and the region was surveyed and photographed in what was thought to be a "climax" condition. The region was then divided into transects (stations) which were designated as IA, IB, IIA, IIB, etc., and a program relative to their denudation set up. Each station was photographed before and after denuding and at low tide periods during the investigation, weather and light conditions permitting. No attempt was made to record horizontal distribution of the various associations noted. The transects were examined from the highest levels in which marine organisms were manifest to the lowest tide levels, and the vertical distribution of all macroscopic forms recorded. The vertical range was noted in centimeters above or below the mean low water datum point (the 0.0 level of tide books). Collections were taken nearly every time observations were made and identification of these herbarium materials was later carried out in the laboratory.

At Nobska Point the unusually low temperatures during the winter of 1947–48 (extremes for this section of Cape Cod) resulted in a complete ice covering over the intertidal area. This provided an excellent opportunity to witness the remarkably destructive effect of ice on the intertidal biota as well as the subsequent repopulation of the areas so denuded. All transects

cleared previously took on at this time the appearance of their immediate surroundings and were lost to view. The intertidal region was then considered to be a series of winter transects scoured of their biota by ice. The subsequent course of repopulation on all transects was similar and the same as that of the surrounding area; so observations after February 21, 1948, were largely confined to one station.

Observations over the six years this investigation has been carried on, tend to support the idea that the problem of classifying the colonizers of denuded transects in the intertidal region as undertaken by Bokenham (1938) and modified by Northcraft (1948) is really a problem of succession. Also, that the course of repopulation, insofar as it concerns any particular succession of species, is dependent on the life cycles and forms of the organisms, as well as the time of clearing in respect to the time of reproduction, particularly of the rapidly-growing longer-lived organisms. Therefore, a classification of the species, from the point of view of their succession in repopulating denuded areas, should include a consideration of growth rate, life cycles and forms and time of reproduction of the species. At Nobska Point the colonizing marine flora and fauna apparently follows a definite order. The first macroscopic forms to appear, i. e., the pioneer colonizers, seemingly vary as to species with the tides and seasons. The "pioneers" are always rapidly-growing forms. They may settle as spores or larvae either over a broad vertical area and then become more narrowly delimited or more rarely they may settle over a restricted range and spread outward. This group may be either transient forms, such as *Enteromorpha*, or persistent forms, such as *Balanus*. Next appear secondary forms which may likewise be of two types: 1) those that are a normal part of the seasonal progression for the area, and 2) those that appear after the pioneers, but which do not persist and which otherwise would not be expected to appear as dominants. Possibly among these latter are the principal "occasional algae" of other workers. Finally, as long as the environment remains uniform or changes cyclically the organisms making up the "climax" situation produce a condition characterized by a certain seasonal progression of forms or by dominants that as species, or communities, seem to reproduce or, at least, maintain

themselves. These latter climax colonizers are slowly-growing or long-lived forms either as species or as individuals.

Recolonization of the transects at Nobska Point compares well with the findings of other investigators. Transects, cleared during the summer and fall, followed a similar sequence during the course of the reestablishment of their biota. The first macroscopic organisms to occur, in all cases, were *Enteromorpha* and *Polysiphonia*. On all rocks sufficiently high, *Calothrix* was an early repopulant.

Some macroscopic forms apparently require a surface unoccupied by other species in order to achieve dominance. One of these is *Balanus* which settled in its second year only within its adult range and on areas free from all algae and older *Balanus*. That is, it was observed in places where old *Balanus* had been worn away by some environmental factor and was observed filling in the spaces between the widely scattered white *Balanus* of the previous year. Bokenham (1938) also mentions this preference of the various species for algae-free rocks. *Enteromorpha* behaved this way in part, for while on one transect it became a dominant form it appeared less so or merely appeared as scattered tufts on the adjacent *Balanus-Ralfsia* settled surfaces. It may very well be that many of the "occasional algae" of Northcraft and of Bokenham are of a similar nature, and likewise might become dominant as pioneers under some circumstances.

On the winter transects *Balanus* was the only macroscopic pioneer below the *Calothrix* zone. *Enteromorpha* failed to appear on the ice-scoured surfaces until more than two months after the *Balanus* has settled. In this case, *Enteromorpha* was not a pioneer even when only the algae are considered. The first macroscopically visible algae which appeared as a coating on the rocks and barnacles were brown algae such as *Chordaria* and *Scytosiphon*. This phenomenon may be taken as evidence that at some seasons certain components (here perhaps *Balanus*) of the complement of forms, expected as pioneers and reproducing at the time, may in some way prevent a form (here *Enteromorpha* which is often a conspicuous colonizer otherwise) from appearing in its usual role. It is possible that the reproductive bodies or juvenile forms were consumed as food by the barnacles.

As one analyzes these recolonization studies many avenues for future investigation and the tremendous amount of experimentation to be done in the field become evident. Because of the difficulties of distinguishing between tidal effects (primary and secondary factors and their chance coincidence), seasonal effects, and the differences between one season and the next (or other) seasons (or cycles, annual or otherwise) a supplementary experiment was felt necessary if biotic succession and seasonal periodicity were to be segregated satisfactorily. It has already been observed that marine organisms in repopulating denuded transects follow a certain course of events leading to the reestablishment of the original pattern of populations. The series of populations has features in common with natural phenomena of the areas already populated (control areas) and features that are unique. Observations tend to support the hypotheses that when tidal variations and seasonal periodicity are eliminated or controlled, biotic succession, when present, can be seen and that the effects of tidal action can be determined by exposing a set of transects to the tides and another to all the same features save the tides.

To test these hypotheses panels were planned for exposure. Eighty pine panels were made up alike in stock and dimensions. A piece of lead was tied to one end and plastic rope to the other end of each panel floated. This immersed the panels in an upright position with about 14 centimeters of the roped end out of water. The panels were numbered and the rope was secured to a wharf so that the panels would neither entangle nor float away. Stationary panels under the same conditions, operationally, were set out. Fisheries Wharf, Woods Hole, Massachusetts was chosen as the site of the experiments. The proximity of the Marine Biological Laboratory facilitated observation and experimentation during both the summer and winter months and offered many other advantages.

Since August 1951 panels have been exposed for overlapping periods of more than two weeks. This controls variation due to periodic fruiting of organisms on non-floating substrata or rhythmically fruiting forms which will provide the reproducing bodies that will initiate growth on these panels. Such panels kept out for a year should show a change in population through the year. If only seasonal periodicity is involved each of the

population changes observed should be of organisms capable of pioneering and should be independent of previous populations. This experiment has been outlined to run for a two year period and observations and collections are currently being made weekly. Since panels are to be exposed for one, two, three, four, six, seven, twelve and twenty-four month periods, they are set out in varying numbers monthly. When removed panels are floated in a tray, examined, photographed and all data carefully recorded. Notes on the dominant species occupying non-experimental nearby areas (pilings, wharf and wall) are taken.

The experiment was designed to run for a year but subsequent observations and complexities indicated this to be too short a time interval and it was deemed wise to continue it through a second year. At the present time the results for eighteen months have been recorded. These results indicate that biotic successions can be demonstrated in the intertidal regions of Woods Hole, Massachusetts, and these may correspond closely to those already noted by Scheer (1935) working at Newport Harbor, California. Redfield & Deevy (1952) have suggested a possible significance in the fact that a high proportion of the evidence for biotic succession comes from the Pacific Coast of North America where seasonal phenomena are less pronounced than elsewhere in the temperate zone. They conclude with the statement, "Where seasonal variations are large, biotic succession may not be obvious." On the basis of my studies I believe that biotic succession is obvious enough where seasonal variations are large but few workers make the necessary long-term observations in a region with the rigorous climatic conditions found in the New England winter.

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Color Form of Helianthus mollis.—Throughout its range ordinary *Helianthus mollis* has deep-yellow or orange-yellow rays and disk flowers. During the summer of 1950 I observed a pale-colored variant of this species growing in a prairie along a railroad in northern Missouri. Unlike the typical color form, the pale variant had the disk pale yellow with the disk flowers yellow-green or pale yellow. The pale yellow rays were shorter than those of ordinary *H. mollis.* Two colonies of the pale-colored form were found in the midst of the ordinary deeper yellow colored phase.

Two plants were transplanted to my wild flower garden in northern Illinois. These were studied during 1951 and the characters of the pale yellow color and short rays were found to persist. It, therefore, seems worthwhile to designate this as a new form.

Helianthus mollis Lam., forma **flavida** Steyermark, f. nov., a typo differt ligulis et disci floribus flavidis; ligulis brevioribus.—Prairie along railroad, route 36, 4.4 mi. northwest of western limit of Lentner, Shelby Co., Missouri, August 21, 1950, *Julian A. Steyermark, 70126,* type, in Herb. Chi. Nat. Hist. Mus.—Julian A. Steyermark, Chicago Natural History Museum and Missouri Botanical Garden.

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